The Belle II Experiment

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on behalf of the Belle II Collaboration

29 May 2015

Belle II

Super KEKB

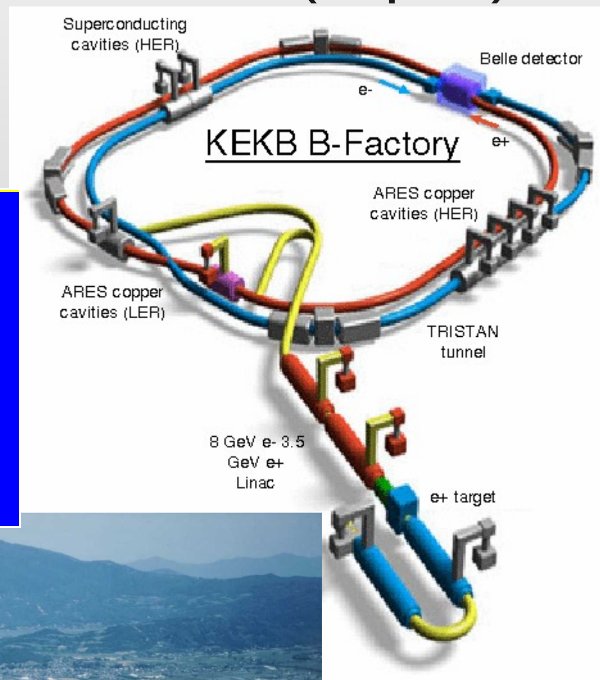
UNIVERSITY of HAWAIʻI MĀNOA

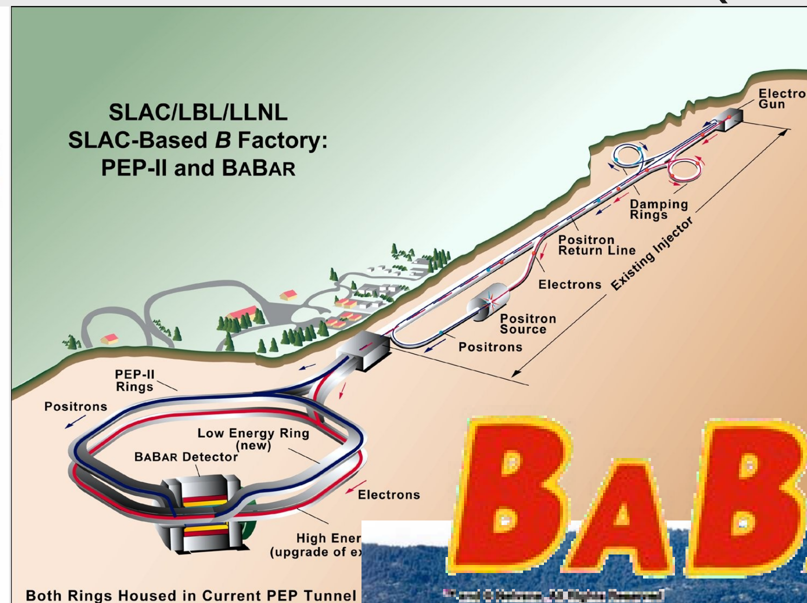
Outline

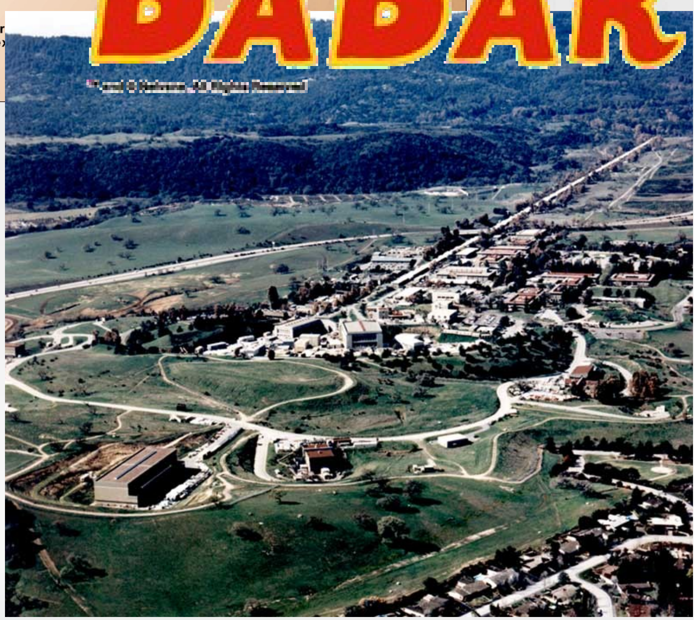
- The B factories.
- Belle II and SuperKEKB:
  - Construction status.
- Belle II:
  - Physics prospects;
  - Schedule and Commissioning.

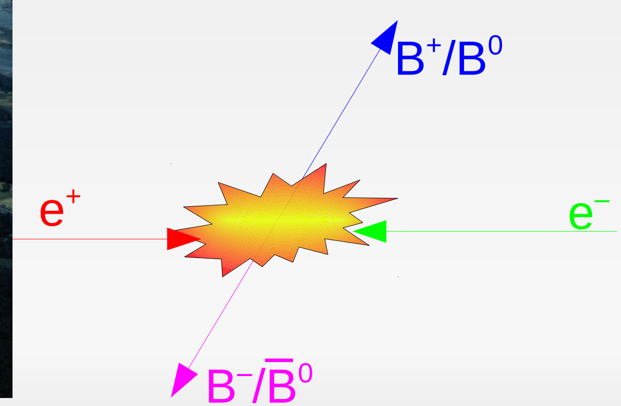
The B factories

- Belle/KEKB at KEK (Japan) and BaBar/PEP-II at SLAC (USA).



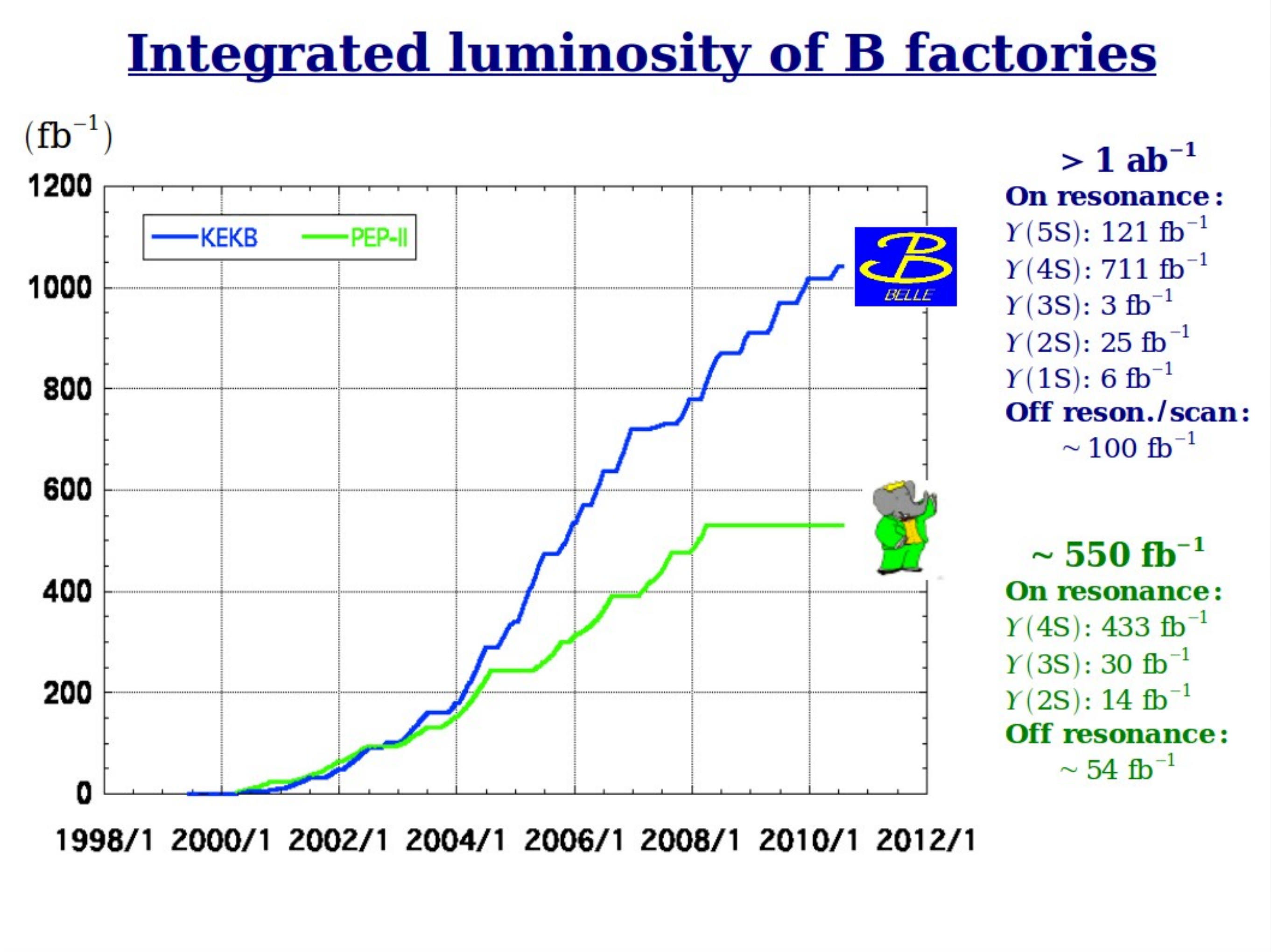






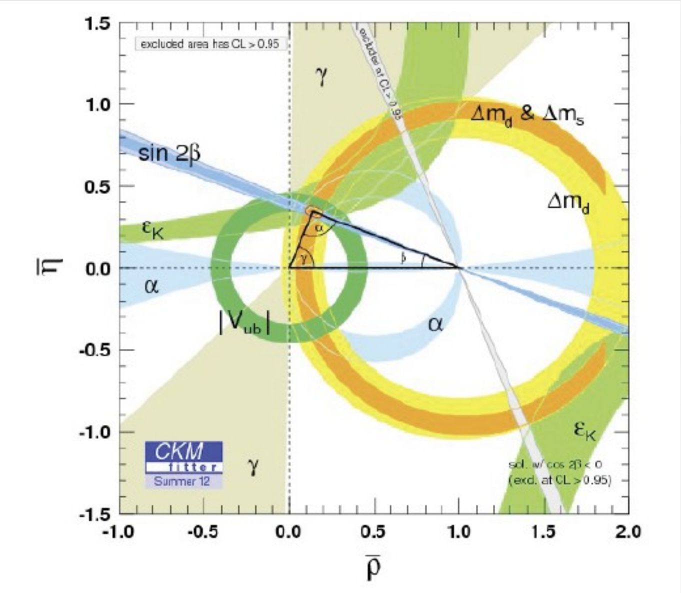
The B factories

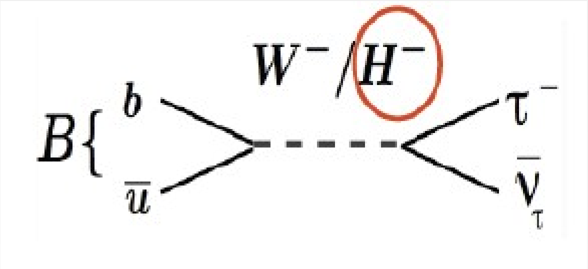
- The B factories: Belle and BaBar ran from 1999 to ~2010.
- They recorded over $1.5ab^{-1}$ of data.
- And provided the experimental confirmation that lead to the 2008 Nobel prize.



The B factories

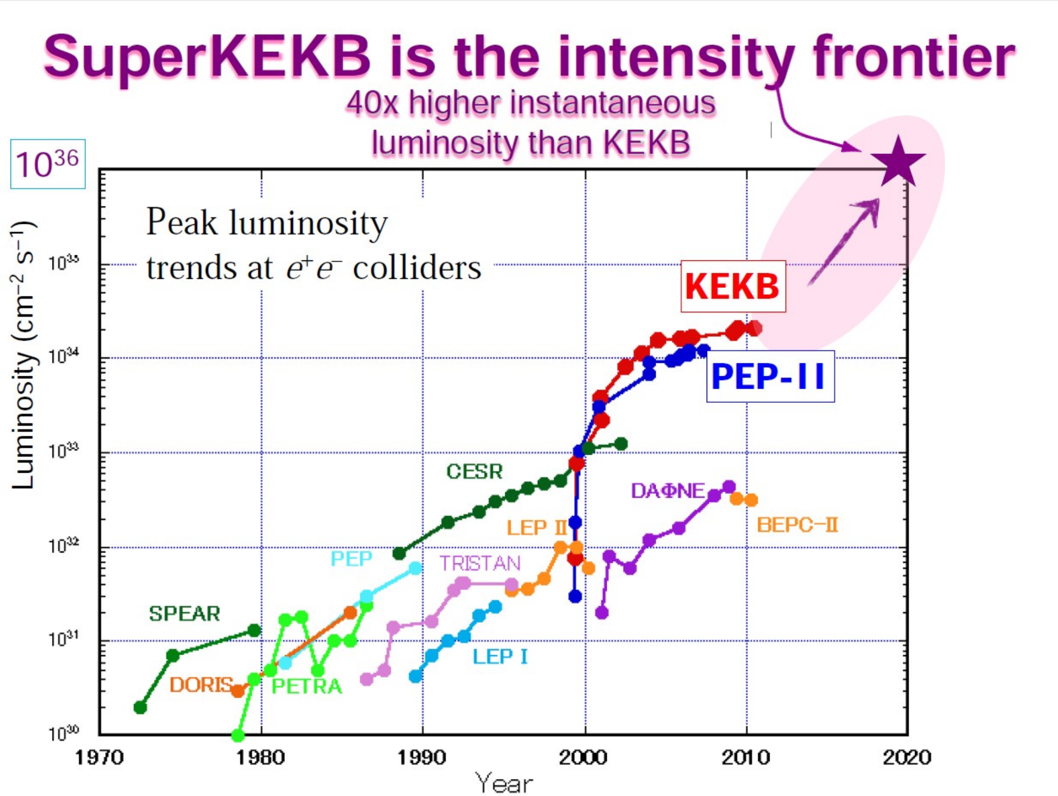
- Physics highlights:
- Measurement of the Unitarity triangle, and CKM parameters;
- Observation of D meson mixing;
- Observation of new (X, Y, Z) hadrons;
- Observation of direct CP violation in B decays;
- In addition to being B factories – also τ and charm factories:
  - Search for rare τ decays.
- Constraints on new physics from:
  - e.g B $\rightarrow$ $\tau\nu$ and B $\rightarrow$ sγ.
- And direct searches for light Higgs, Dark photon...

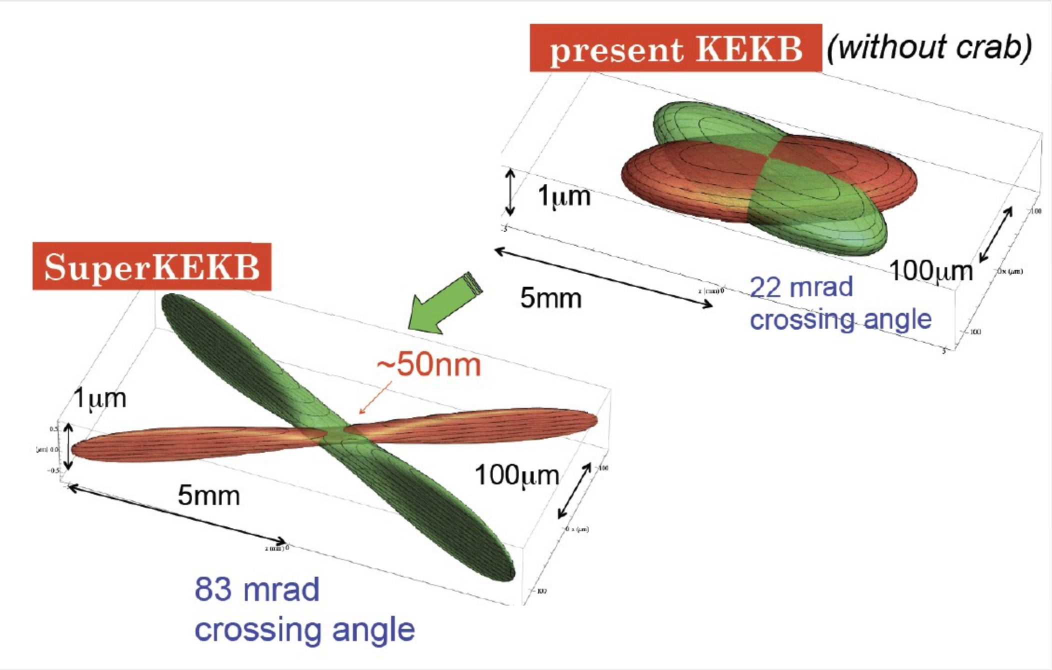




Belle II and SuperKEKB

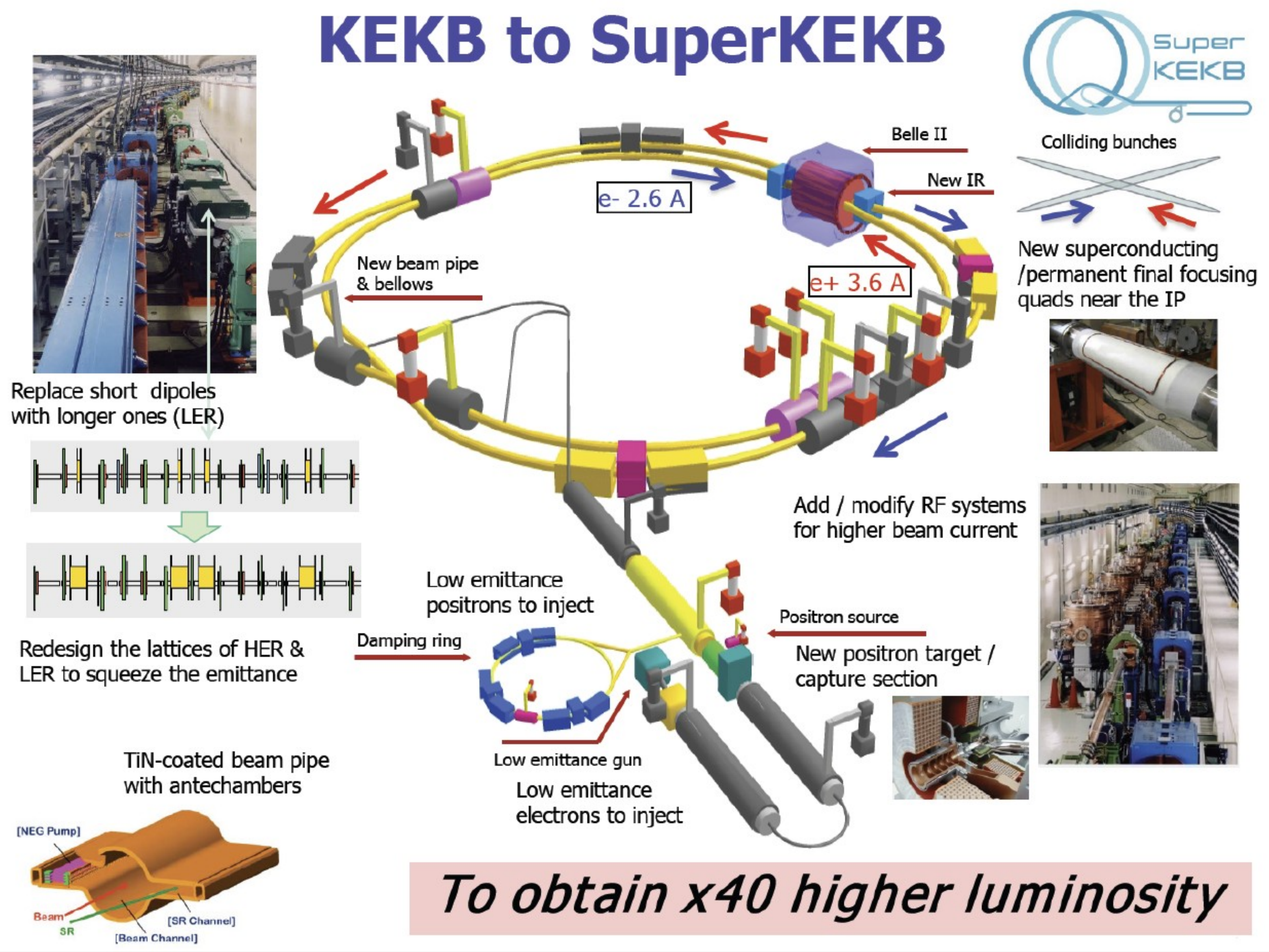
SuperKEKB





- 40x increase in instantaneous luminosity.
- Beam currents are increased by ~2, but the main increase in luminosity comes from the change in beamspot size from using nanobeams.

SuperKEKB



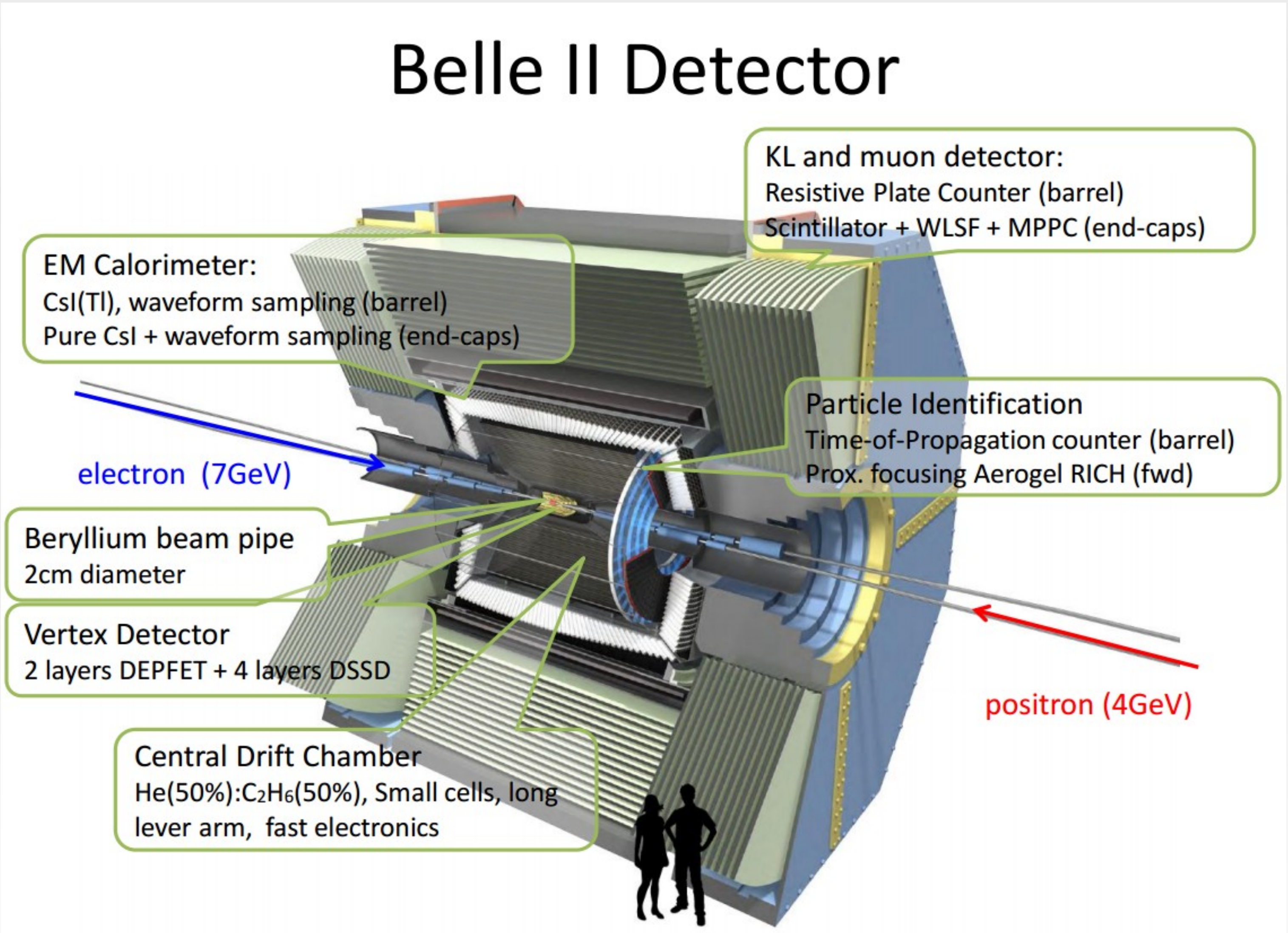
KEKB to SuperKEKB
Super KEKB
Belle II
New IR
Colliding bunches
e- 2.6 A
e+ 3.6 A
New beam pipe & bellows
New superconducting /permanent final focusing quads near the IP
Replace short dipoles with longer ones (LER)
Add / modify RF systems for higher beam current
Low emittance positrons to inject
Positron source
New positron target / capture section
Damping ring
Redesign the lattices of HER & LER to squeeze the emittance
Low emittance gun
Low emittance electrons to inject
TiN-coated beam pipe with antechambers
[NEG Pump]
Beam
SR
[SR Channel]
[Beam Channel]
To obtain x40 higher luminosity

Belle II Collaboration

- ~600 collaborators, 99 institutions, 23 countries (as of May 2015).

From Belle to Belle-II

- The Belle detector is being upgraded to become Belle II.
- All subdetectors upgraded or replaced.
- To cope with the increased luminosity to be provided by SuperKEKB.

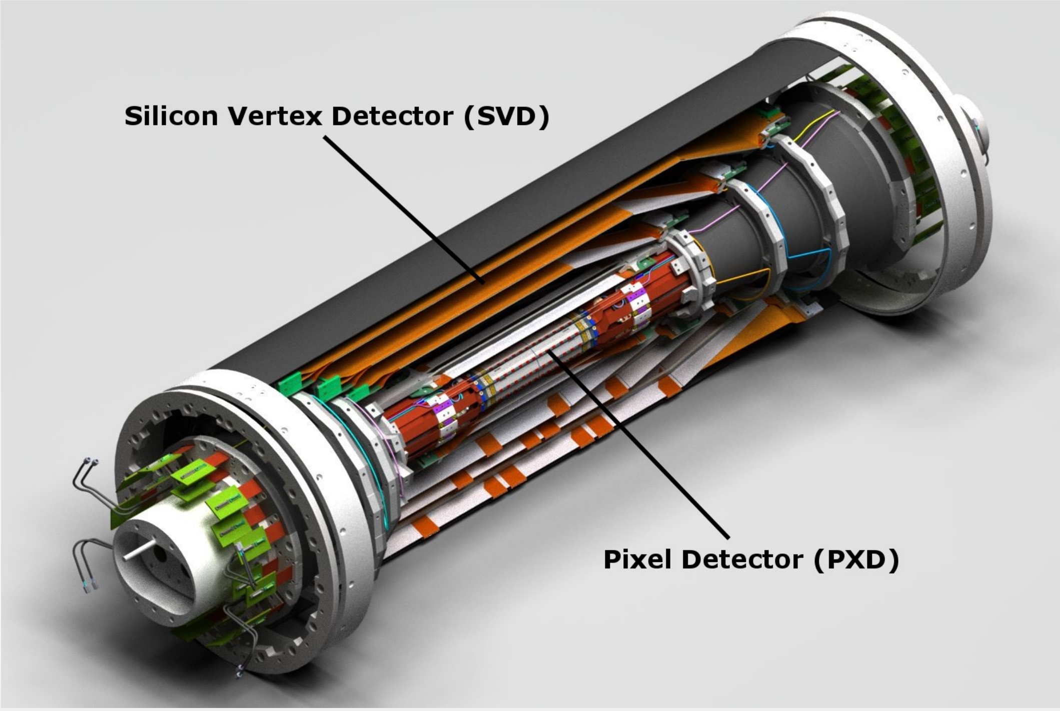


Belle II subdetectors

Vertex detectors

- New vertex detectors: 2 layers of DEPFETs (Depleted P- Channel Field Effect Transistor) and 4 layers of DSSD (Double Sided Silicon Detectors).
- Beam pipe radius reduced from 2cm-1.5cm for Belle to 1cm for Belle II.

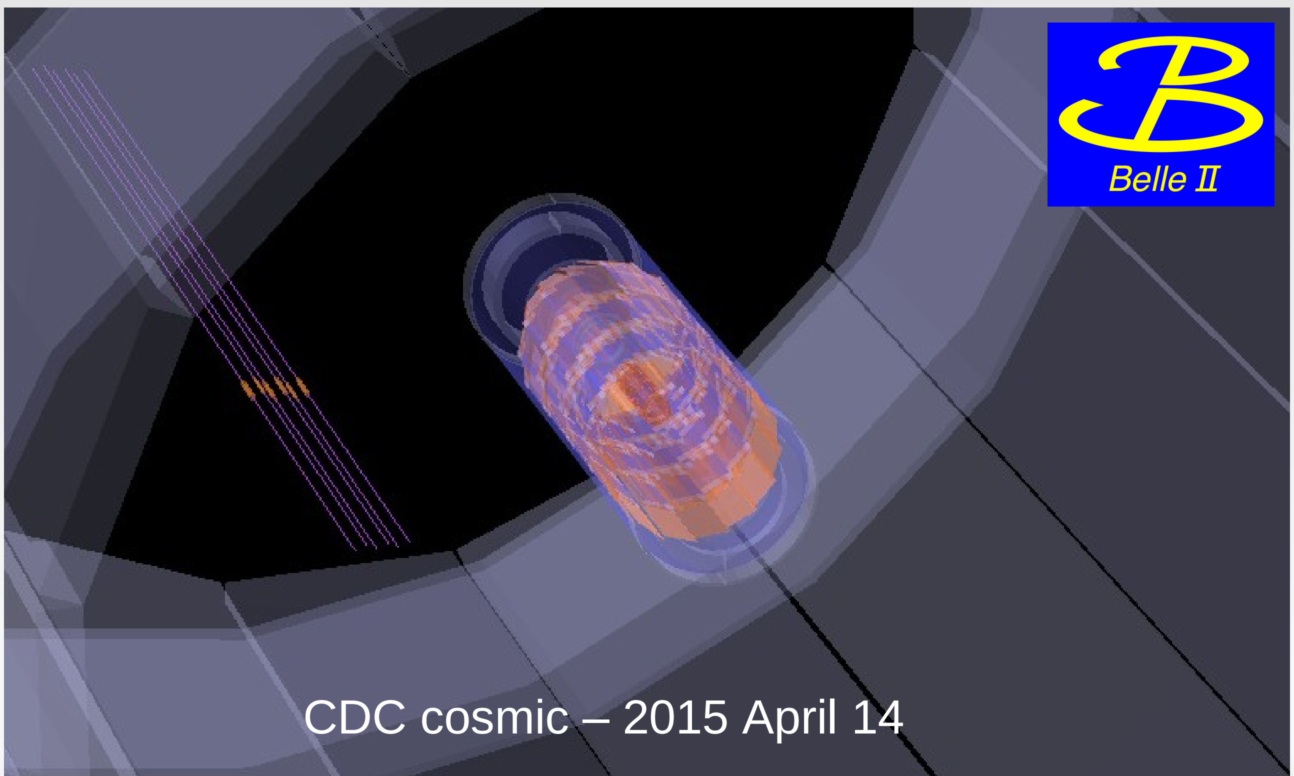
Beam Pipe		**r = 10mm**
DEPFET		
	Layer 1	**r = 14mm**
	Layer 2	**r = 22mm**
DSSD		
	Layer 3	**r = 38mm**
	Layer 4	**r = 80mm**
	Layer 5	**r = 115mm**
	Layer 6	**r = 140mm**



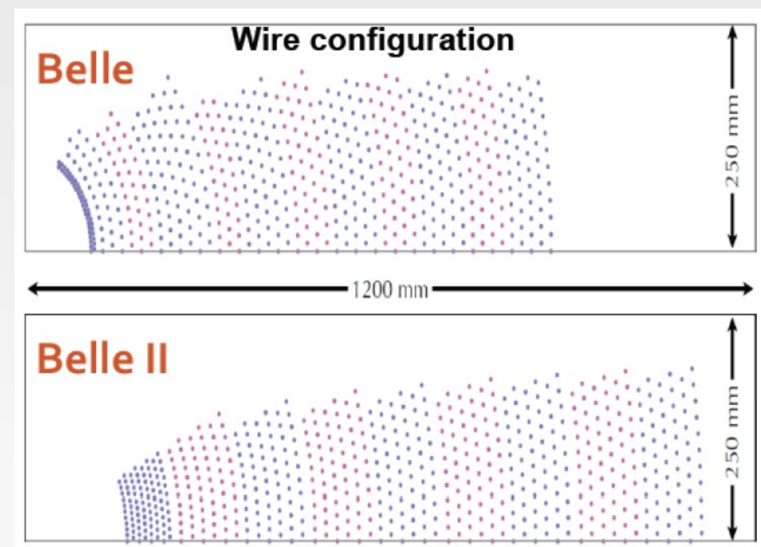
Central Drift Chamber (CDC)

- CDC for Belle II will be larger than Belle CDC.
- Stringing completed in January 2014 – 51456 wires.
- Commissioning with cosmic rays under way.

	Belle	Belle II
Innermost sense wire	r=88mm	r=168mm
Outermost sense wire	r=863mm	r=1111.4mm
Number of layers	50	56
Total sense wires	8400	14336
Gas	He:C_2H_6	He:C_2H_6
Sense wire	W(Φ30μm)	W(Φ30μm)
Field wire	Al(Φ120μm)	Al(Φ120μm)

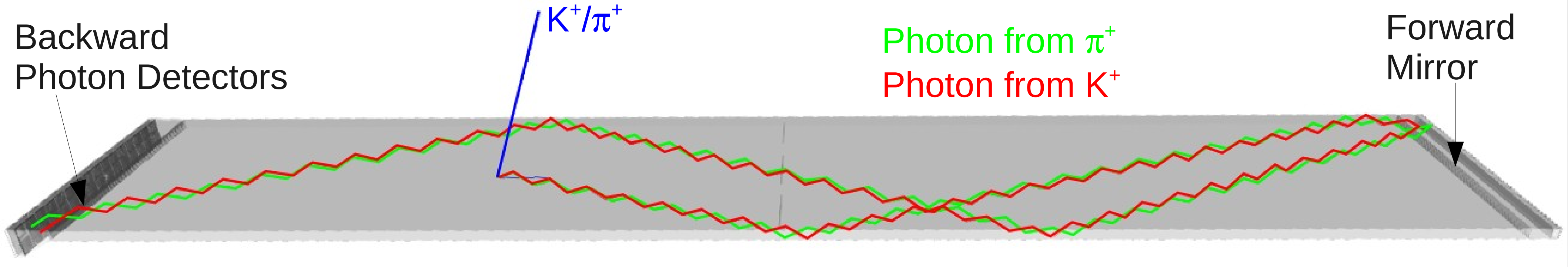


CDC cosmic – 2015 April 14

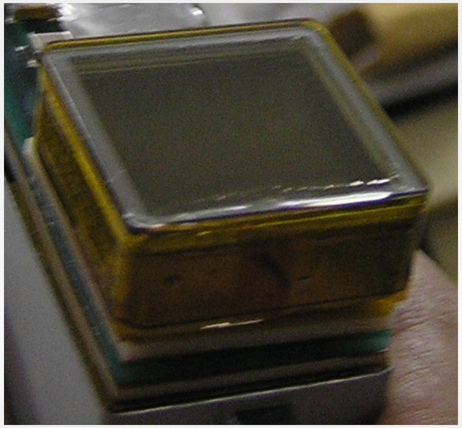


The TOP detector

- The (imaging) Time of Propagation subdetector (TOP or iTOP) will be used for particle identification in the barrel region of Belle II.
- Each TOP module contains two quartz bars, mirror, prism, and an array of photodetectors to detect Cerenkov photons from charged tracks.

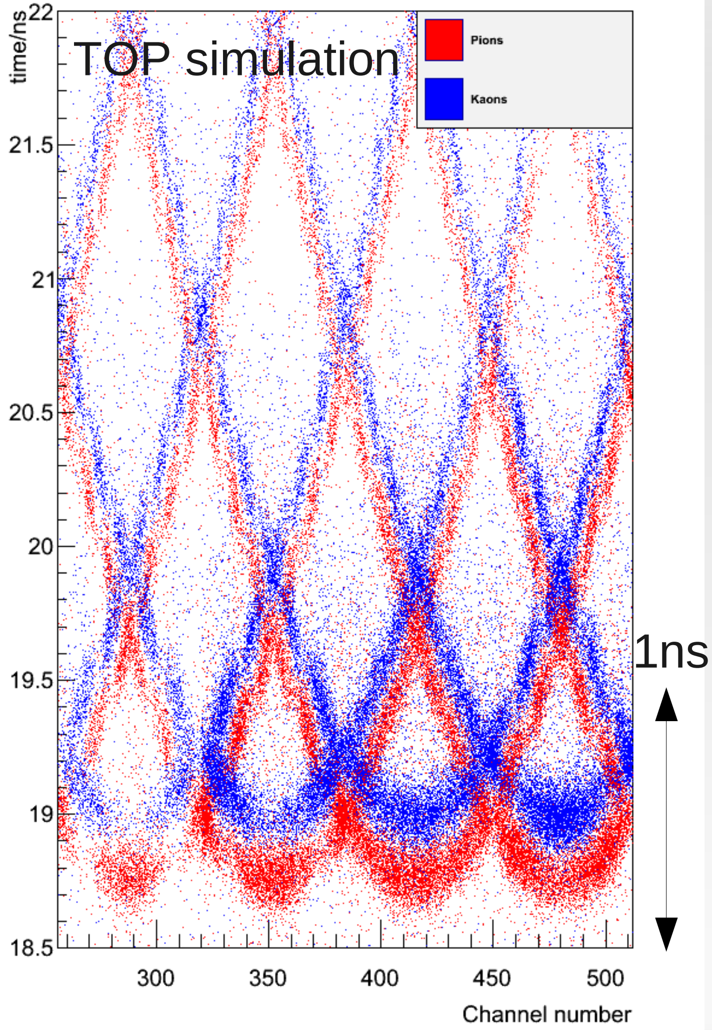


- To distinguish between kaons and pions, excellent position and timing resolution is required.
- This is achieved using MCP-PMTs and new waveform sampling electronics.



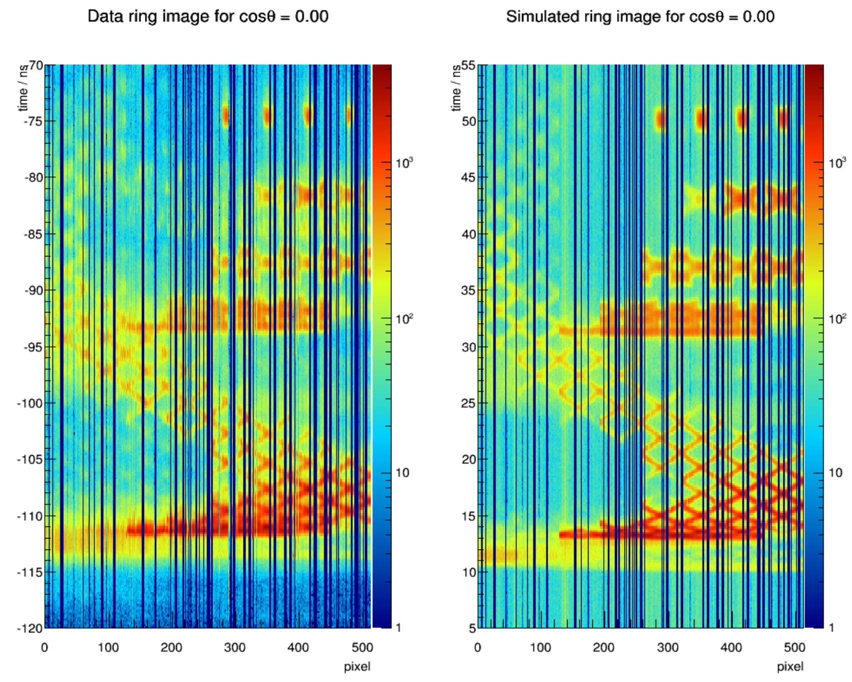
The TOP detector

Photon detection time vs channel number (zoom)



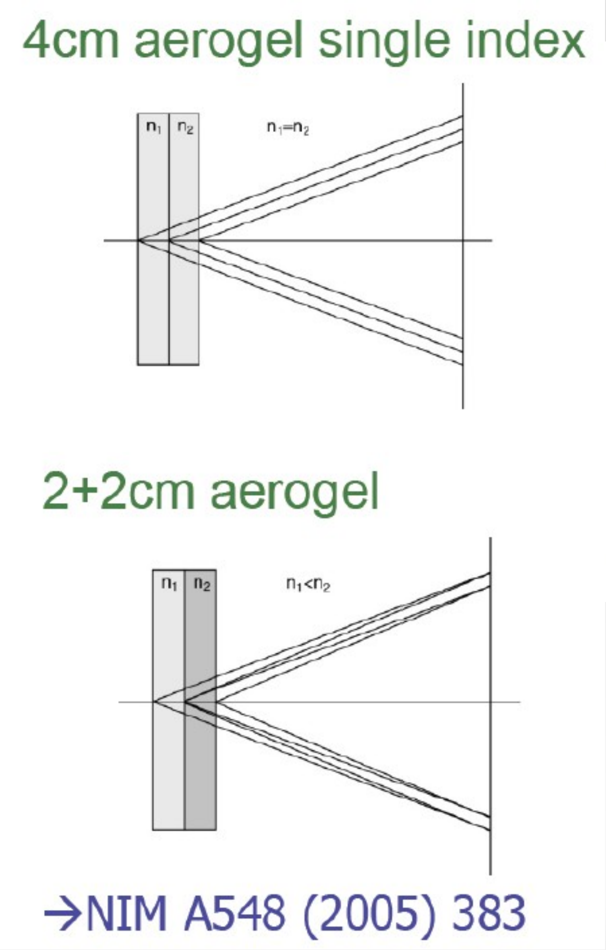
- To distinguish between kaons and pions timing resolution of O(100ps) is required.
- TOP modules have been tested at beam tests, and good agreement between data and simulation has been obtained, with timing requirement reached.
- First Final TOP modules have been constructed;
- Commissioning with cosmic rays is under way, prior to installation.

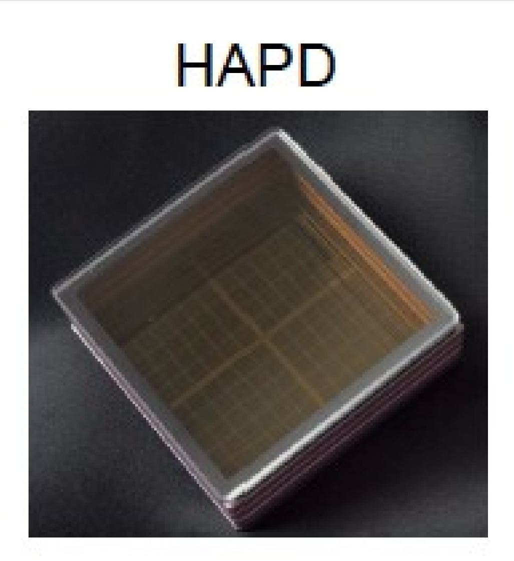
Beam Test at LEPS (June 2013)

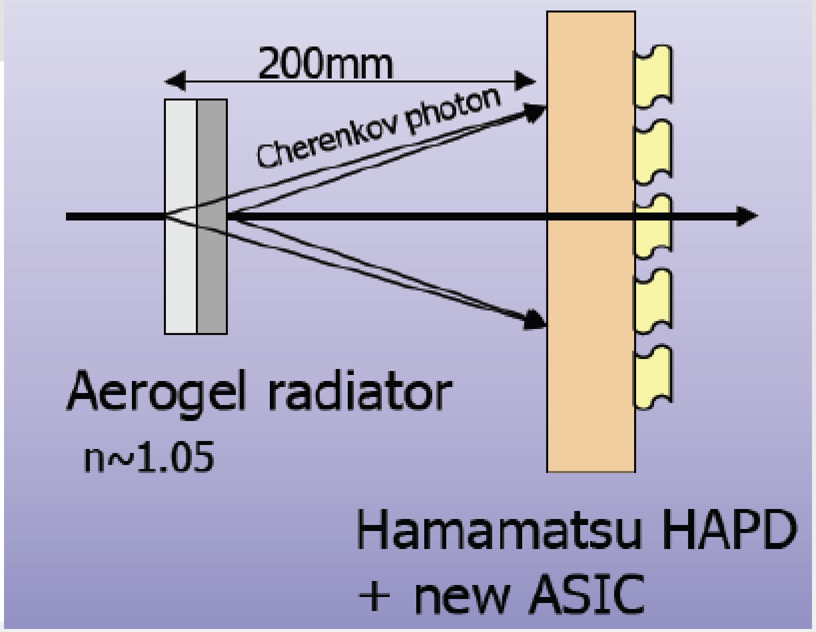


Aerogel RICH

- Aerogel Ring Imaging Cerenkov (ARICH) detector used for particle identification in the forward endcap.

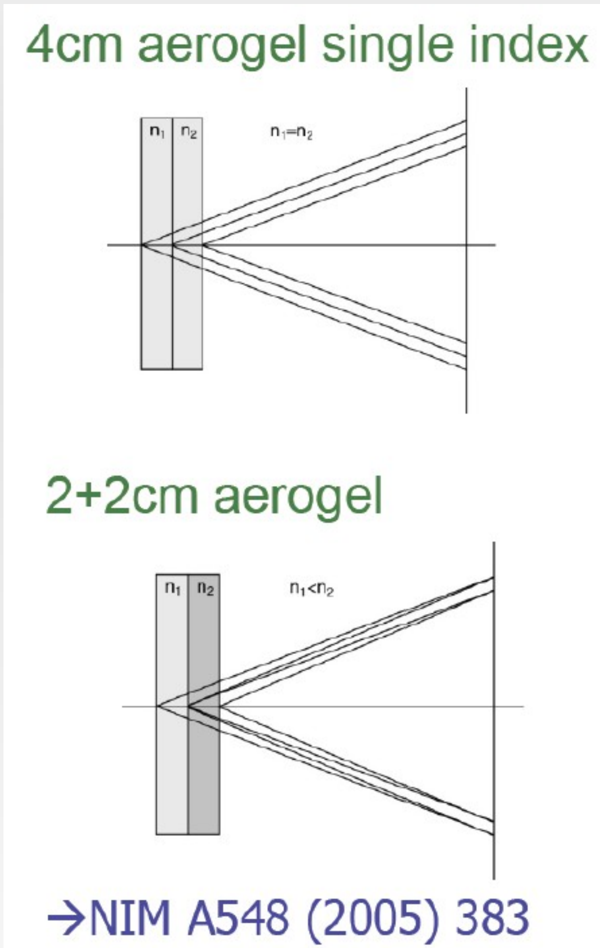


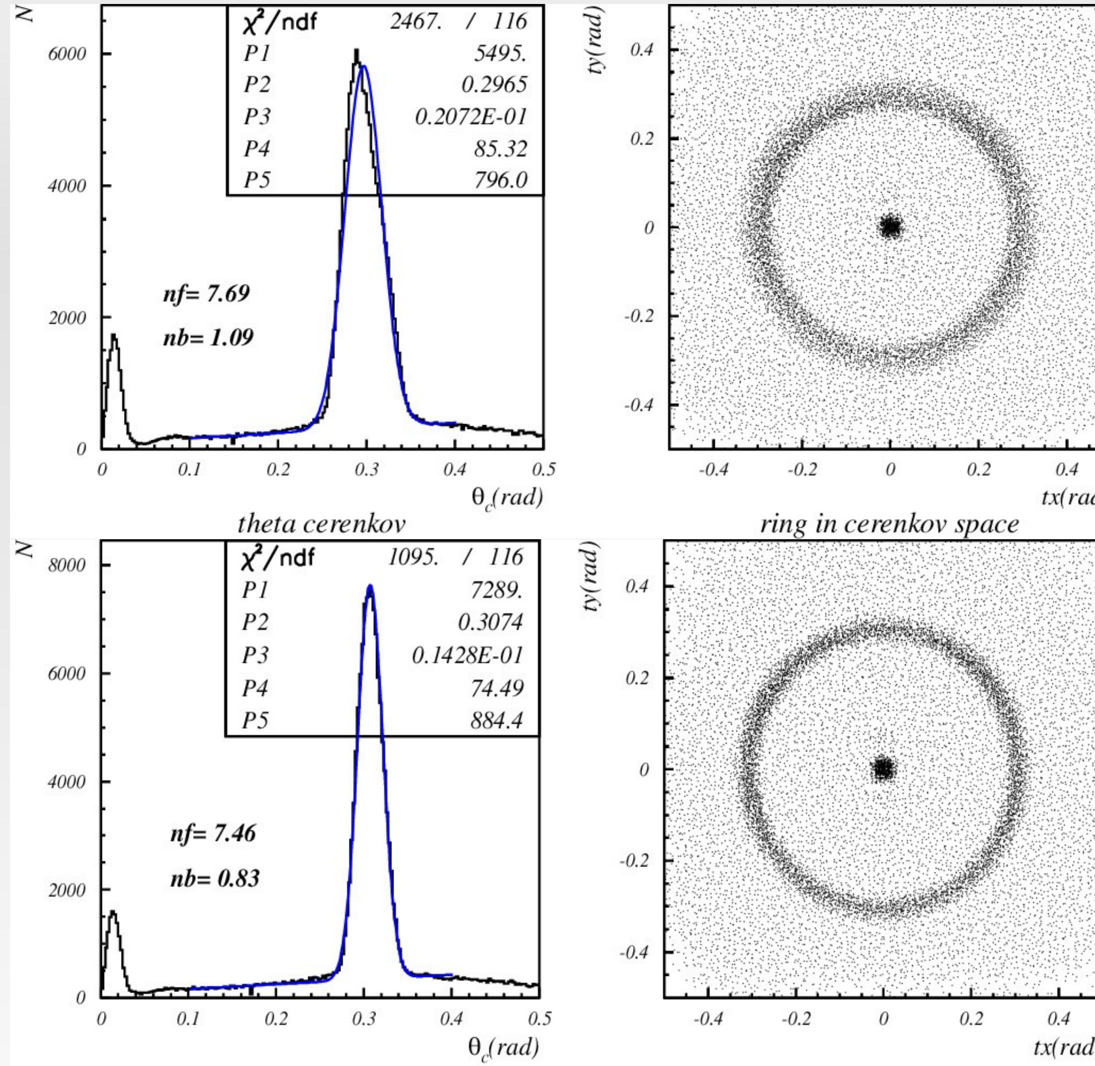




Uses 420 Hybrid Avalanche Photo Detectors (HAPD), each with 144 channels.

Aerogel RICH





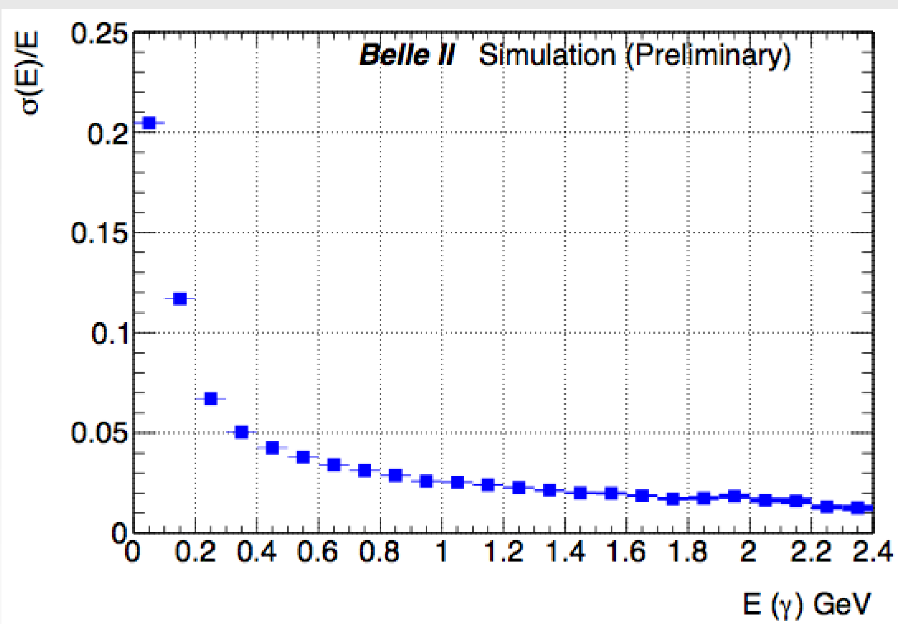
Two layers of aerogel lead to better photon yield, whilst maintaining resolution.

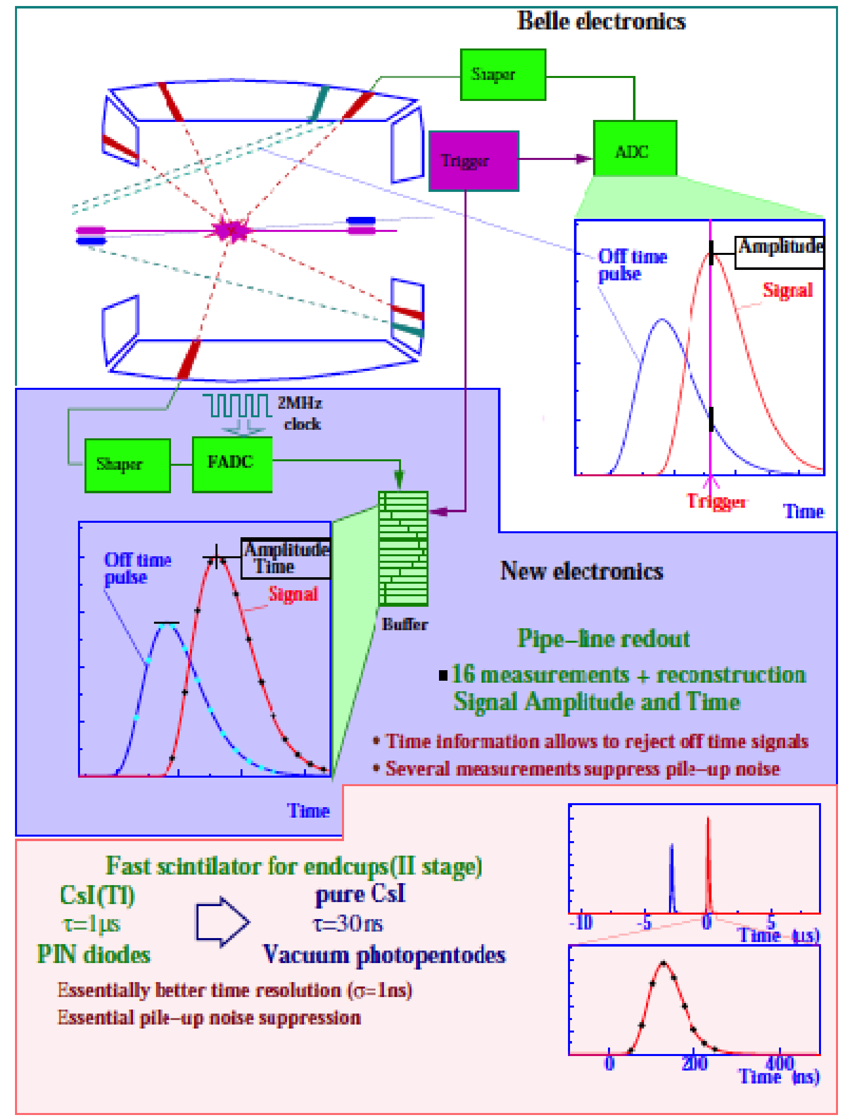
NIM A548 (2005) 383

Electromagnetic Calorimeter (ECL)

- Need upgrade for high backgrounds
- Barrel: CsI(Tl), waveform sampling.
- Endcaps: CsI(Tl), waveform sampling.

Expected performance from Geant4 simulation.



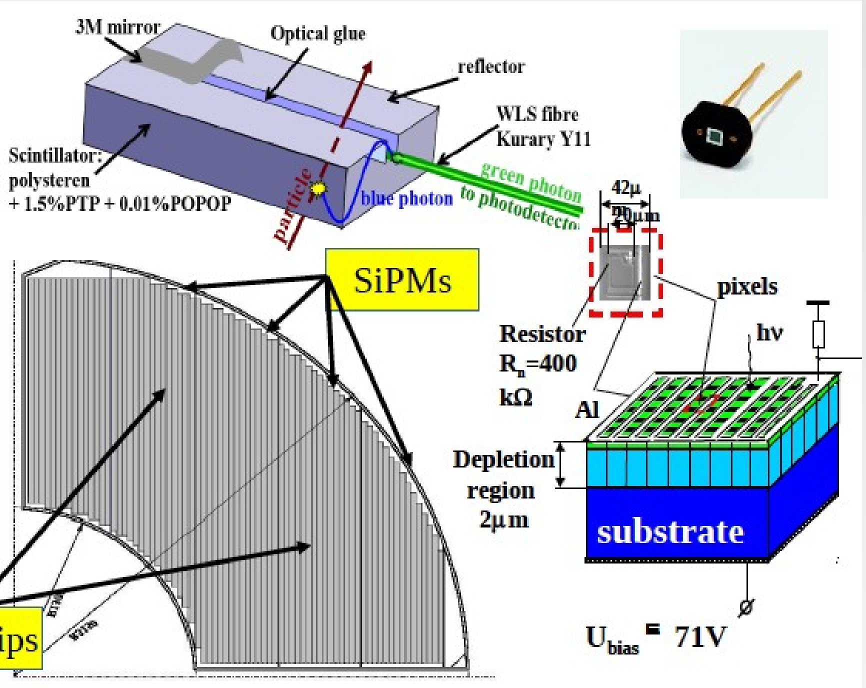


K_L and Muon systems (KLM)

- Endcaps and parts of the barrel KLM RPCs of Belle needed to be replaced with scintillators due to increased backgrounds expected in Belle II.
- Barrel KLM was the first sub-detector to be installed in Belle II.

TDR efficiencies for RPC

Layer	Endcap forward	
	KEKB	SuperKEKB
0	0.91	0.0
1	0.93	0.0
2	0.94	0.0
3	0.94	0.0
4	0.94	0.0
5	0.92	0.0
6	0.93	0.0
7	0.92	0.0
8	0.92	0.0
9	0.90	0.0
10	0.87	0.0
11	0.82	0.0
12	0.78	0.0
13	0.77	0.0
14	N/A	N/A



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Physics Prospects

Belle II physics prospects

- Many potential sources/signals of new physics:
  - Flavour changing neutral currents;
  - Lepton flavour violating decays;
  - $B \to \tau$ new physics in loops;
  - Precision CKM measurements/ new sources of CPV
- Different modes will be favourable to search for at different experiments.
- Belle II physics programme will be complementary with LHCb.

	Observables	Belle or LHCb* (2014)	Belle II 5 ab^{-1}	Belle II 50 ab^{-1}
UT angles	$\sin 2\beta$	$0.667 \pm 0.023 \pm 0.012 (1.4°)$	0.7°	0.4°
	α [°]	85 ± 4 (Belle+BaBar)	2	1
	γ [°] $(B \to D^{(*)} K^{(*)})$	68 ± 14	6	1.5
	$2\beta_s (B_s \to J/\psi \phi)$ [rad]	$0.07 \pm 0.09 \pm 0.01^*$		
Gluonic penguins	$S(B \to \phi K^0)$	$0.90^{+0.09}_{-0.19}$	0.053	0.018
	$S(B \to \eta' K^0)$	$0.68 \pm 0.07 \pm 0.03$	0.028	0.011
	$S(B \to K^0_S K^0_S K^0_S)$	$0.30 \pm 0.32 \pm 0.08$	0.100	0.033
	$\beta^{\text{eff}}_s (B_s \to \phi\phi)$ [rad]	$-0.17 \pm 0.15 \pm 0.03^*$		
	$\beta^{\text{eff}}_s (B_s \to K^{*0} \bar{K}^{*0})$ [rad]	–		
Direct CP in hadronic Decays	$\mathcal{A}(B \to K^0 \pi^0)$	$-0.05 \pm 0.14 \pm 0.05$	0.07	0.04
UT sides	$\|V_{cb}\|$ incl.	$41.6 \cdot 10^{-3} (1 \pm 2.4\%)$	1.2%	
	$\|V_{cb}\|$ excl.	$37.5 \cdot 10^{-3} (1 \pm 3.0\%_{\text{ex.}} \pm 2.7\%_{\text{th.}})$	1.8%	1.4%
	$\|V_{ub}\|$ incl.	$4.47 \cdot 10^{-3} (1 \pm 6.0\%_{\text{ex.}} \pm 2.5\%_{\text{th.}})$	3.4%	3.0%
	$\|V_{ub}\|$ excl. (had. tag.)	$3.52 \cdot 10^{-3} (1 \pm 10.8\%)$	4.7%	2.4%
Leptonic and Semi-tauonic	$\mathcal{B}(B \to \tau \nu)$ [10^{-6}]	$96 (1 \pm 26\%)$	10%	5%
	$\mathcal{B}(B \to \mu \nu)$ [10^{-6}]	< 1.7	20%	7%
	$R(B \to D \tau \nu)$ [Had. tag]	$0.440 (1 \pm 16.5\%)^\dagger$	5.6%	3.4%
	$R(B \to D^* \tau \nu)^\dagger$ [Had. tag]	$0.332 (1 \pm 9.0\%)^\dagger$	3.2%	2.1%
Radiative	$\mathcal{B}(B \to X_s \gamma)$	$3.45 \cdot 10^{-4} (1 \pm 4.3\% \pm 11.6\%)$	7%	6%
	$A_{CP}(B \to X_{s,d} \gamma)$ [10^{-2}]	$2.2 \pm 4.0 \pm 0.8$	1	0.5
	$S(B \to K^0_S \pi^0 \gamma)$	$-0.10 \pm 0.31 \pm 0.07$	0.11	0.035
	$2\beta^{\text{eff}}_s (B_s \to \phi \gamma)$	–		
	$S(B \to \rho \gamma)$	$-0.83 \pm 0.65 \pm 0.18$	0.23	0.07
	$\mathcal{B}(B_s \to \gamma\gamma)$ [10^{-6}]	< 8.7	0.3	–
Electroweak penguins	$\mathcal{B}(B \to K^{*+} \nu \bar{\nu})$ [10^{-6}]	< 40	< 15	30%
	$\mathcal{B}(B \to K^{+} \nu \bar{\nu})$ [10^{-6}]	< 55	< 21	30%
	C_7/C_9 $(B \to X_s \ell\ell)$	~20%	10%	5%
	$\mathcal{B}(B_s \to \tau\tau)$ [10^{-3}]	–	< 2	–
	$\mathcal{B}(B_s \to \mu\mu)$ [10^{-9}]	$2.9^{+1.1}_{-1.0}{}^*$		

Summary of Belle II prospects

	Observables	Belle or LHCb* (2014)	Belle II 5 ab^{-1}	Belle II 50 ab^{-1}
UT angles	$\sin 2\beta$	$0.667 \pm 0.023 \pm 0.012 (1.4^\circ)$	0.7°	0.4°
	α [°]	85 ± 4 (Belle+BaBar)	2	1
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	$\beta_s^{\rm eff}(B_s \to \phi\phi)$ [rad]	$-0.17 \pm 0.15 \pm 0.03^*$		
	$\beta_s^{\rm eff}(B_s \to K^{*0} \bar{K}^{*0})$ [rad]	–		
Direct CP in hadronic Decays	$\mathcal{A}(B \to K^0 \pi^0)$	$-0.05 \pm 0.14 \pm 0.05$	0.07	0.04
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	$A_{CP}(B \to X_{s,d} \gamma)$ [10^{-2}]	$2.2 \pm 4.0 \pm 0.8$	1	0.5
	$S(B \to K^0_S \pi^0 \gamma)$	$-0.10 \pm 0.31 \pm 0.07$	0.11	0.035
	$2\beta_s^{\rm eff}(B_s \to \phi\gamma)$	–		
	$S(B \to \rho\gamma)$	$-0.83 \pm 0.65 \pm 0.18$	0.23	0.07
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	$\mathcal{B}(B \to K^{+} \nu\bar{\nu})$ [10^{-6}]	< 55	< 21	30%
	C_7/C_9 $(B \to X_s \ell\ell)$	~20%	10%	5%
	$\mathcal{B}(B_s \to \tau\tau)$ [10^{-3}]	–	< 2	–
	$\mathcal{B}(B_s \to \mu\mu)$ [10^{-9}]	$2.9^{+1.1*}_{-1.0}$		

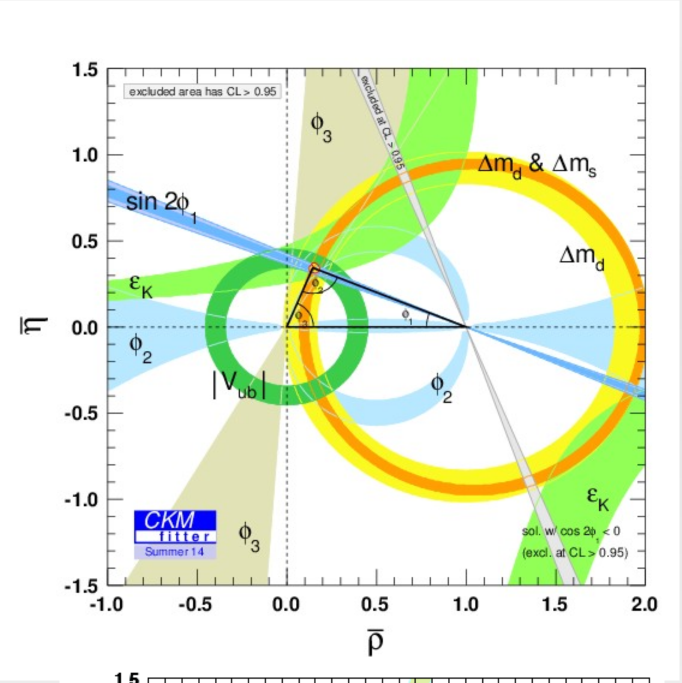
	Observables	Belle (2014)	Belle II 5 ab^{-1}	Belle II 50 ab^{-1}
Charm Rare	$\mathcal{B}(D_s \to \mu\nu)$	$5.31 \cdot 10^{-3} (1 \pm 5.3\% \pm 3.8\%)$	2.9%	0.9%
	$\mathcal{B}(D_s \to \tau\nu)$	$5.70 \cdot 10^{-3} (1 \pm 3.7\% \pm 5.4\%)$	3.5%	2.3%
	$\mathcal{B}(D^0 \to \gamma\gamma)$ [10^{-6}]	< 1.5	30%	25%
Charm CP	$A_{CP}(D^0 \to K^+K^-)$ [10^{-4}]	$-32 \pm 21 \pm 9$	11	6
	$\Delta A_{CP}(D^0 \to K^+K^-)$ [10^{-4}]	3.4^*		
	A_Γ [10^{-2}]	0.22	0.1	0.03
	$A_{CP}(D^0 \to \pi^0\pi^0)$ [10^{-2}]	$-0.03 \pm 0.64 \pm 0.10$	0.29	0.09
	$A_{CP}(D^0 \to K^0_S \pi^0)$ [10^{-2}]	$-0.21 \pm 0.16 \pm 0.09$	0.08	0.03
Charm Mixing	$x(D^0 \to K^0_S \pi^+\pi^-)$ [10^{-2}]	$0.56 \pm 0.19 \pm {}^{0.07}_{0.13}$	0.14	0.11
	$y(D^0 \to K^0_S \pi^+\pi^-)$ [10^{-2}]	$0.30 \pm 0.15 \pm {}^{0.05}_{0.08}$	0.08	0.05
	$\lvert q/p\rvert(D^0 \to K^0_S \pi^+\pi^-)$	$0.90 \pm {}^{0.16}_{0.15} \pm {}^{0.08}_{0.06}$	0.10	0.07
	$\phi(D^0 \to K^0_S \pi^+\pi^-)$ [°]	$-6 \pm 11 \pm {}^{4}_{5}$	6	4
Tau	$\tau \to \mu\gamma$ [10^{-9}]	< 45	< 14.7	< 4.7
	$\tau \to e\gamma$ [10^{-9}]	< 120	< 39	< 12
	$\tau \to \mu\mu\mu$ [10^{-9}]	< 21.0	< 3.0	< 0.3

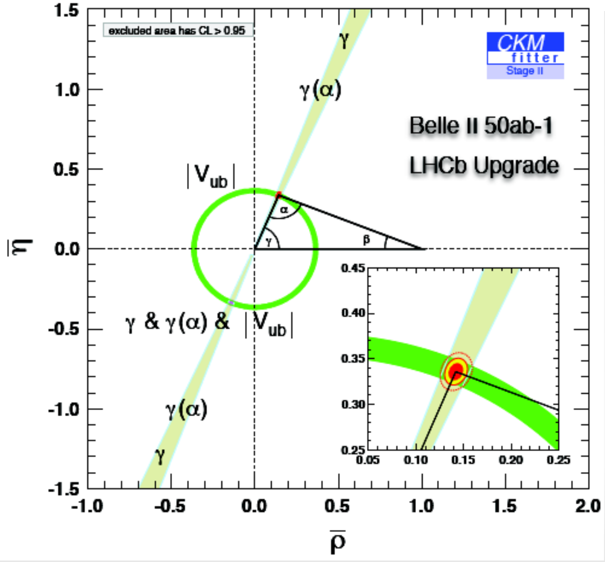
BELLE2-NOTE-PH-2015-02

Unitarity Triangle

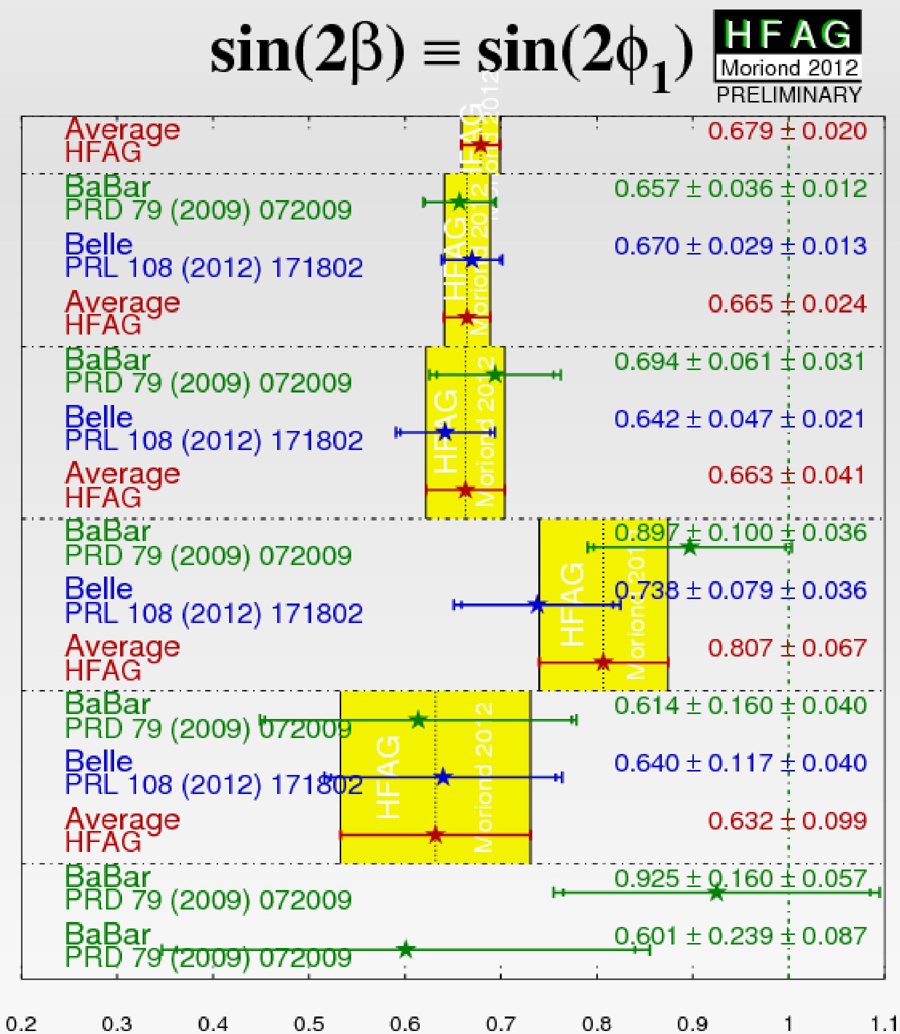
- The B factories have greatly constrained the parameters of the Unitarity Triangle.
- New results from Belle II and LHCb will further (over)constrain the UT.
- Expected reach of Belle II with $50ab^{-1}$:

UT	2014	Belle II
α	4° (WA)	**1°**
β	0.8° (WA)	**0.2°**
γ	8.5° (WA) 14°(Belle)	**1-1.5°**

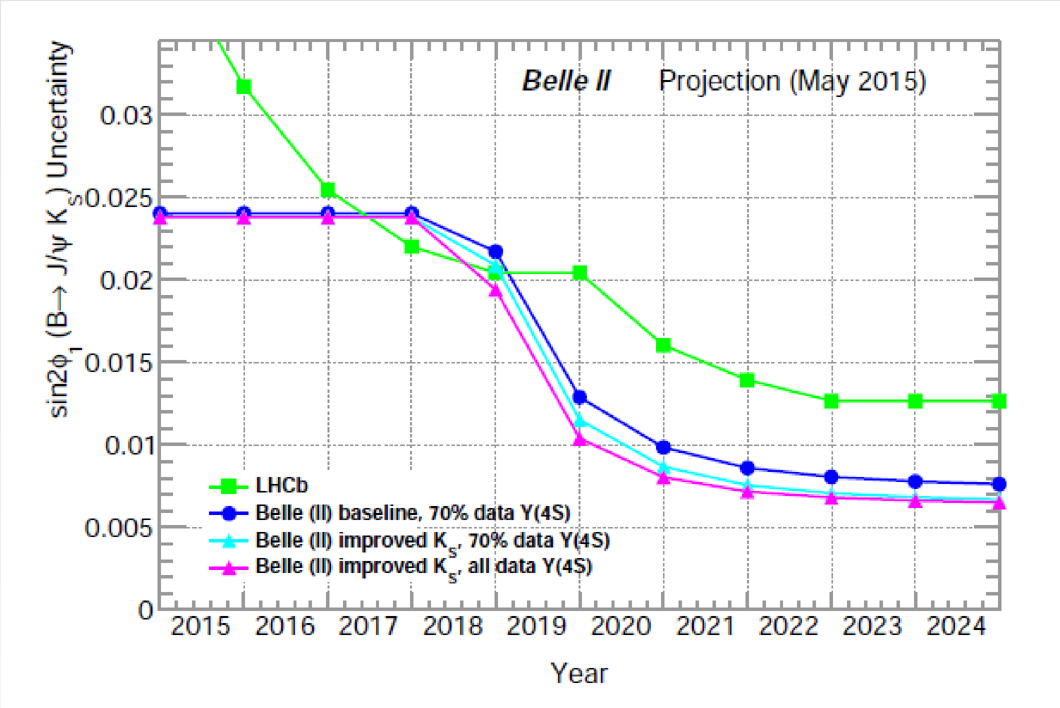




The angle ϕ_1 ($\equiv\beta$)



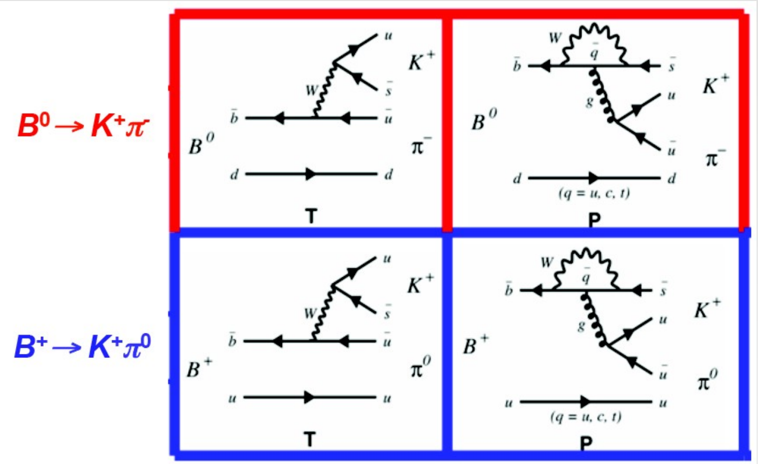
Belle II projection for sin $2\phi_1$ from $B \to J/\psi K_S$:



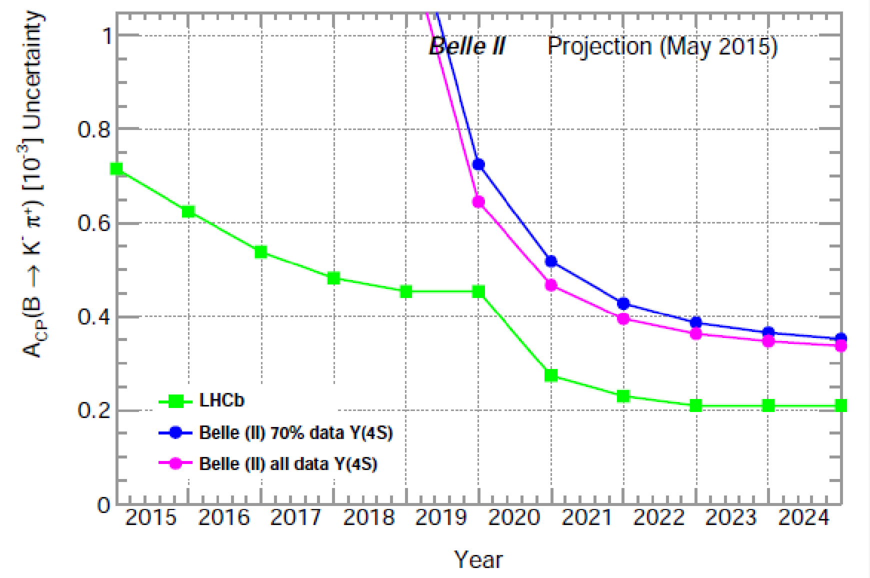
BELLE2-NOTE-PH-2015-02:
LHCb projections taken from:
HL-LHC ECFA Workshop 2014,
LHCb-PUB-2014-040,
LHCb EPJC 73, 2373.

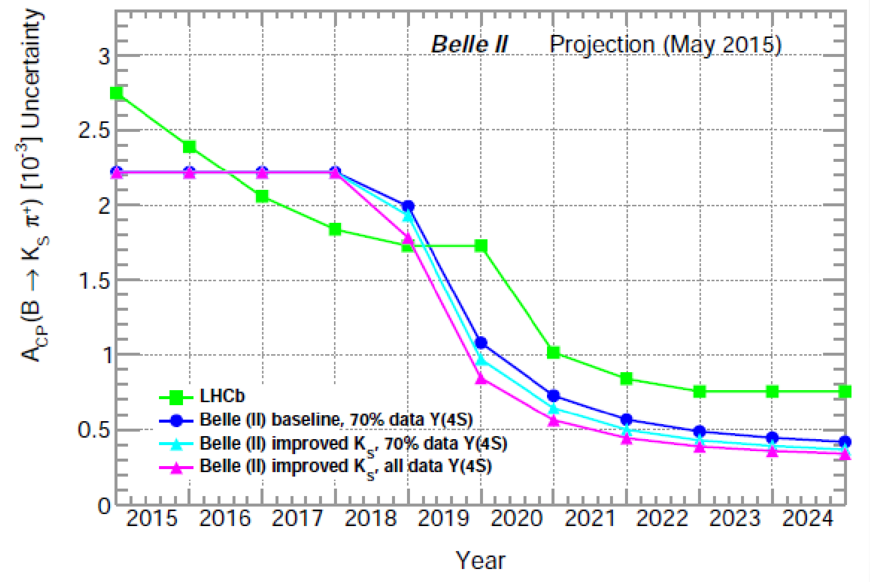
Direct CPV – $B \to K\pi$ modes

- Different ACP values measured for different modes.



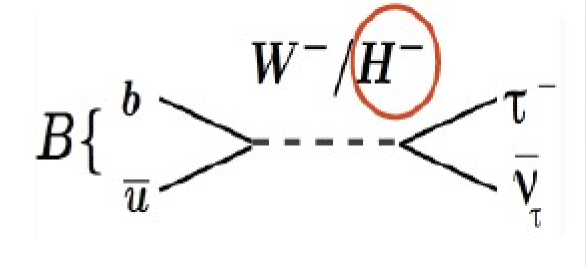
- Complete analysis requires all $B \to K\pi$ modes.
  - Will require neutral modes, such as $B \to K^0\pi^0$, where Belle II will have greater sensitivity.





$B \to \tau\nu$ and $B \to D^{(*)}\tau\nu$

$$\mathcal{B}(B^- \to \ell^- \bar{\nu}) = \frac{G_F^2 m_B}{8\pi} m_l^2 \left(1 - \frac{m_l^2}{m_B^2}\right)^2 f_B^2 |V_{ub}|^2 \tau_B$$



- $B \to \tau\nu$: possible enhancement from charged Higgs.
  - e.g. 2HDM: $\mathcal{B}(B^+ \to \tau^+ \nu) = \mathcal{B}_{SM} \cdot \left(1 - m_B^2 \frac{\tan^2\beta}{m_H^2}\right)$
- Experimentally challenging due to the presence of two (or more) neutrinos in the final state.
  - e+e- colliders preferable to hadron colliders.
- Current measurements have seen evidence for this decay at:
  - 3.6σ (Belle semileptonic tag);
  - 3.0σ (Belle hadronic tag);
  - 2.8σ excess seen at BaBar.

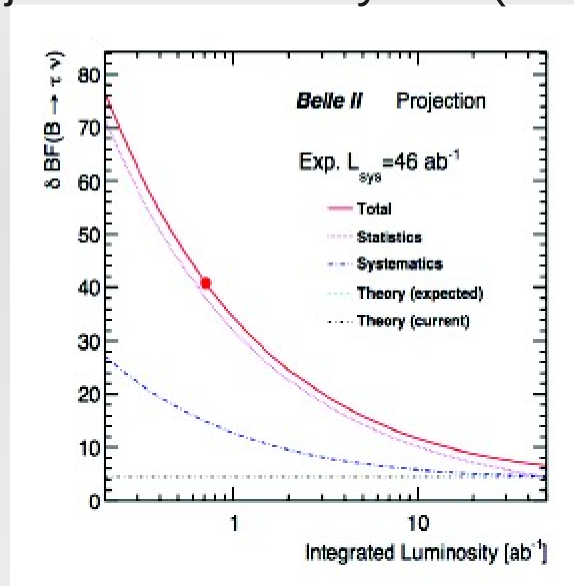
PRD 82, 071101(R) (2010), PRL 110 131801 (2013),
PRD 77 011107(R) (2008), PRD 81, 051101(R), 2010.

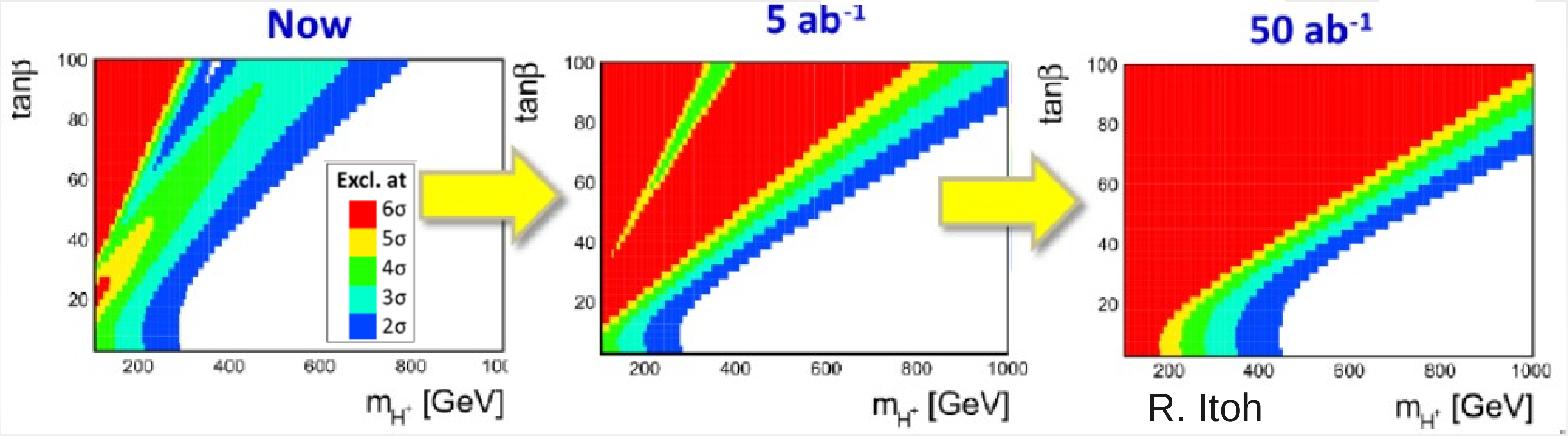
$B \to \tau\nu$ and $B \to D^{(*)}\tau\nu$

Belle II has the potential for an observation of $B \to \tau\nu$ in first years of data taking.

Constraints on $B \to \tau\nu$ apply on m_{H+}-tan β plane could rule out certain charged Higgs models.

Projected uncertainty on $\mathcal{B}(B \to \tau\nu)$



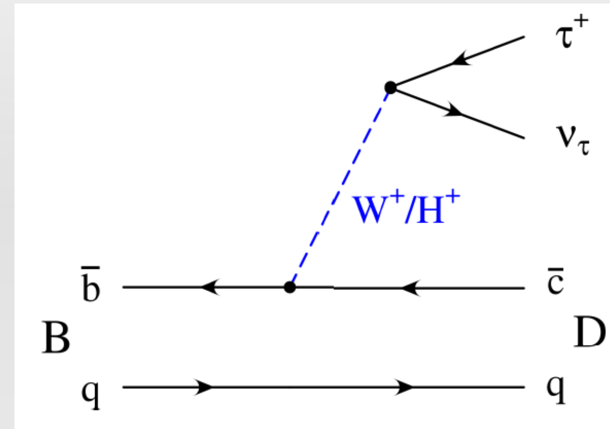


R. Itoh

$B \to \tau\nu$ and $B \to D^{(*)}\tau\nu$

- Sensitivity to charged Higgs:

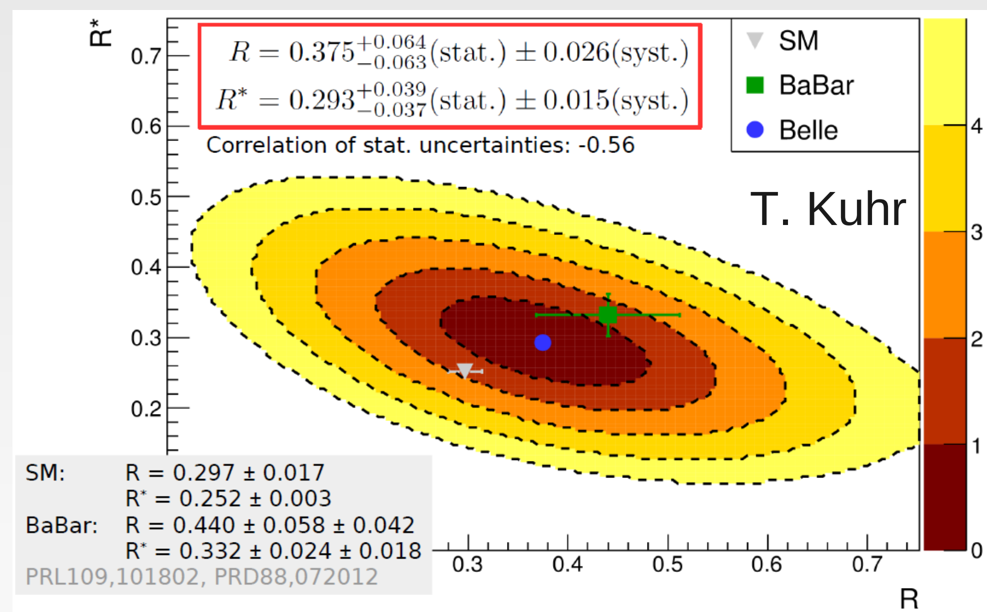
$$\mathcal{B}(B \to D^{(*)}\tau\nu) \propto \mathcal{B}_{SM} \cdot m_W \left(\frac{\tan\beta}{m_H}\right)$$



- BaBar results for $B \to D^{(*)}\tau\nu$ saw 3.4σ deviation from SM and excluded the type II 2HDM at 99.8% CL.

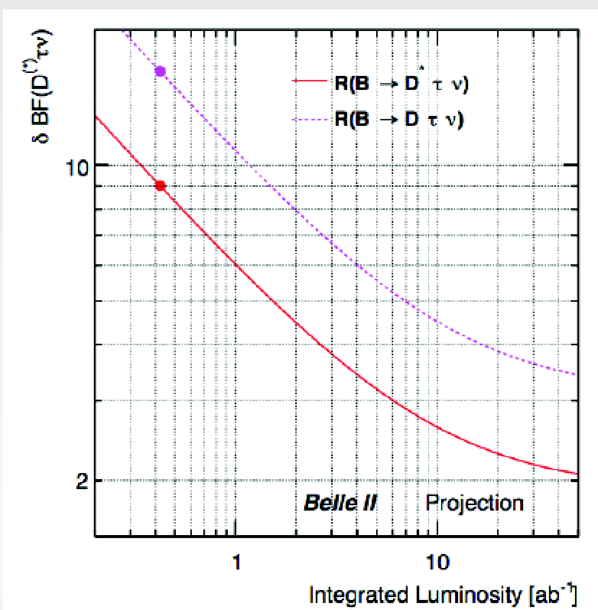
PRL 109, 101802 (2012)

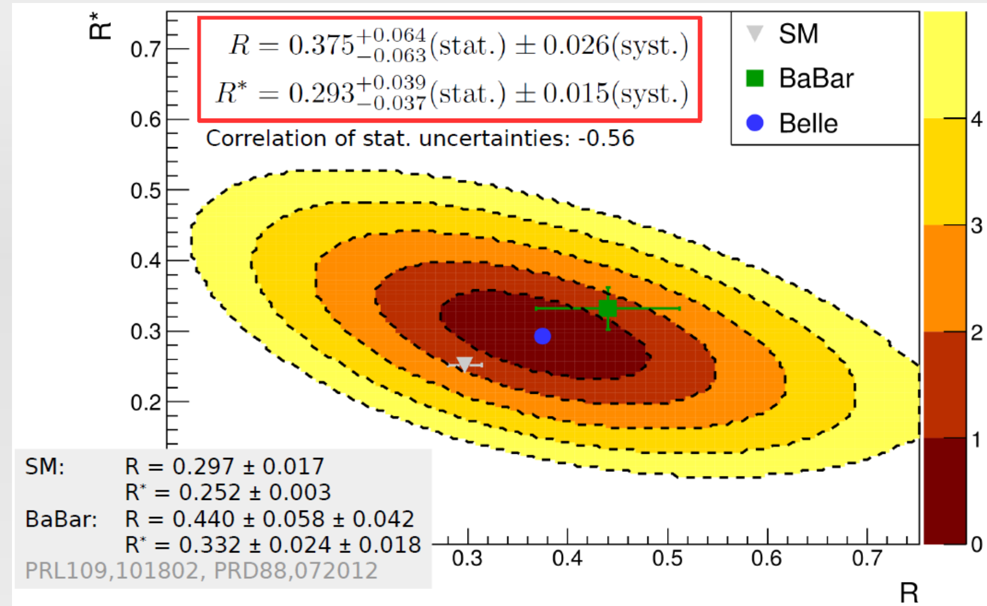
- But new results presented at this conference:
  - Belle – $B \to D^{(*)}\tau\nu$ T. Kuhr.
  - LHCb – $B \to D^{*}\tau\nu$ G. Ciezarek.

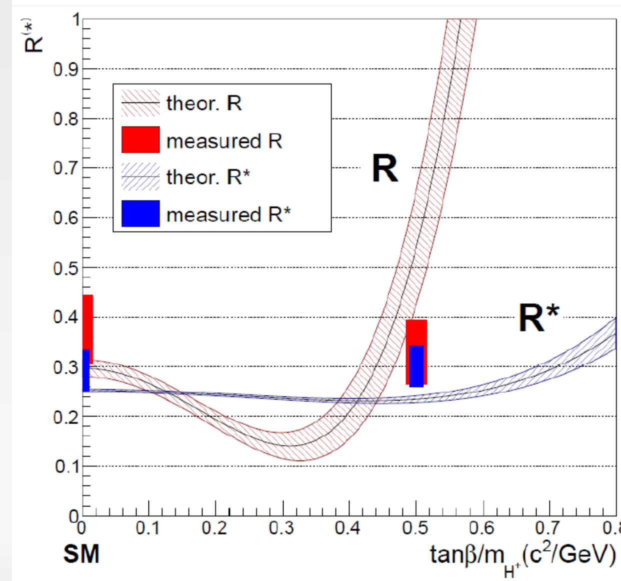


$B \to \tau\nu$ and $B \to D^{(*)}\tau\nu$

- LHCb result consistent with SM.
- Belle result consistent with BaBar result and SM, and also 2HDM.
  - Belle II could potentially resolve SM/2HDM with projected uncertainty:







- Analysis repeated for 2HDM of type II with $\tan\beta/m_{H+}$ = 0.5 c^2/GeV:

$$R = 0.329 \pm 0.060 \pm 0.022$$
$$R^* = 0.301 \pm 0.039 \pm 0.015$$

$$R_{2HDM} = 0.590 \pm 0.125$$
$$R^*_{2HDM} = 0.241 \pm 0.007$$

T. Kuhr

D-D̄ mixing

- Belle II will be competitive with LHCb for y_{CP}, and potentially for x'^2, y', ϕ, |q/p| as well.
- Current measurements yield important constraints on NP.
- Future results could yield NP – results from both LHCb and Belle II would be crucial for any confirmation.

Projected Uncertainties (M. Staric)

Analysis	Observable	Uncertainty (%)	
		Now (~ 1 ab^{-1})	$\mathcal{L} = 50$ ab^{-1}
$K^0_S \pi^+\pi^-$	x	0.21	0.08
	y	0.17	0.05
	$\lvert q/p \rvert$	18	6
	ϕ	0.21 rad	0.07 rad
$\pi^+\pi^-$, K^+K^-	y_{CP}	0.25	0.04
	A_Γ	0.22	0.03
$K^+\pi^-$	x'^2	0.025	0.003
	y'	0.45	0.04
	$\lvert q/p \rvert$	0.6	0.06
	ϕ	0.44	0.04 rad

D-$\bar{D}$ mixing

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- Current measurements yield important constraints on NP.
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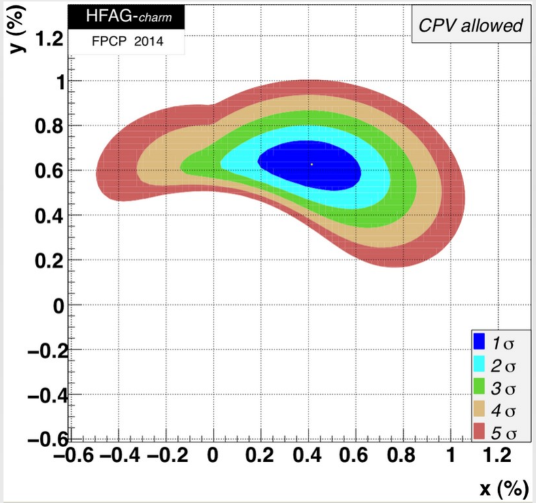
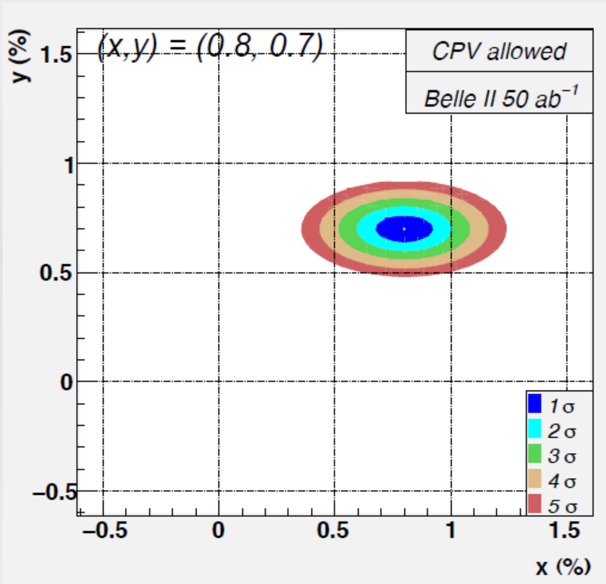
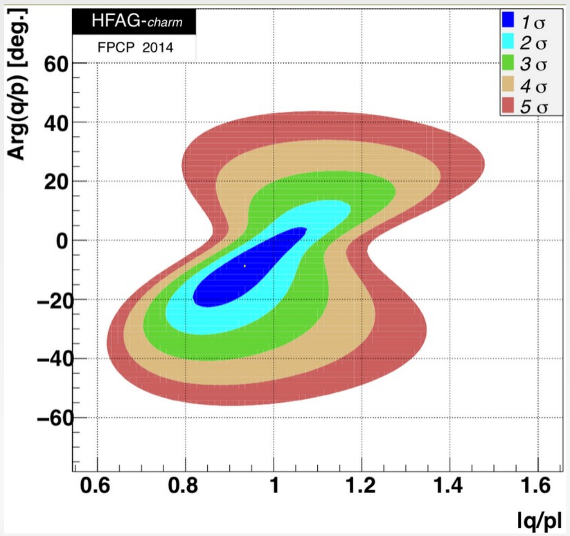
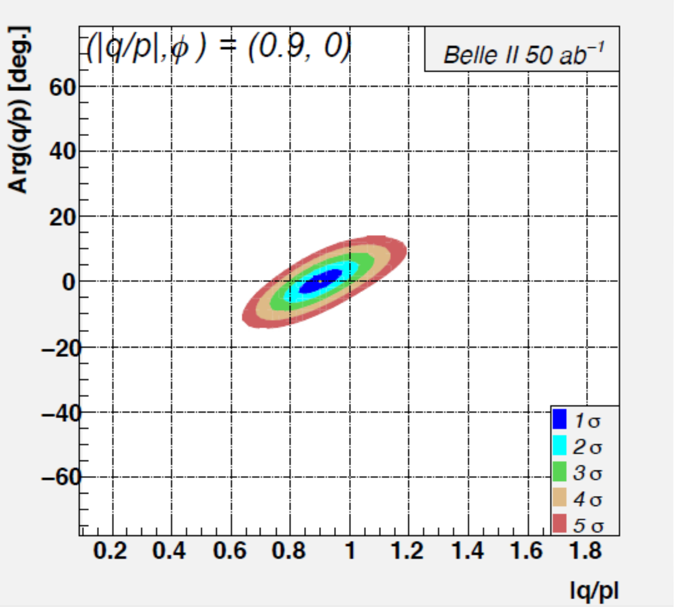




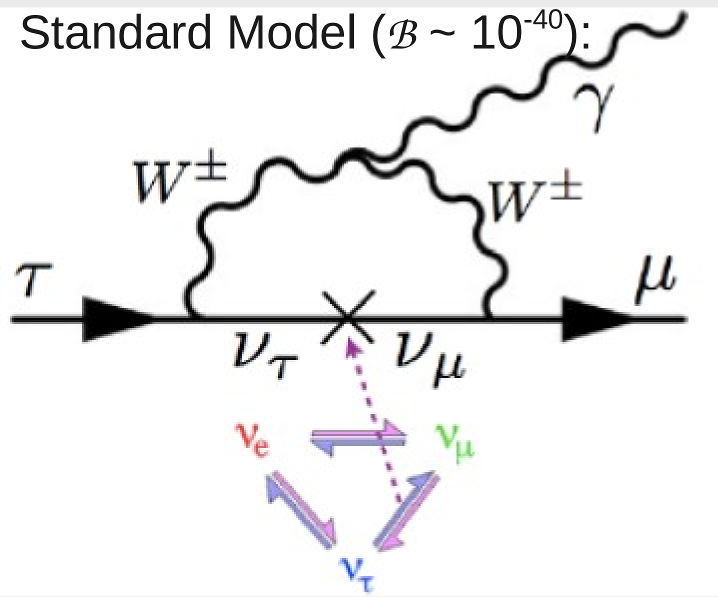




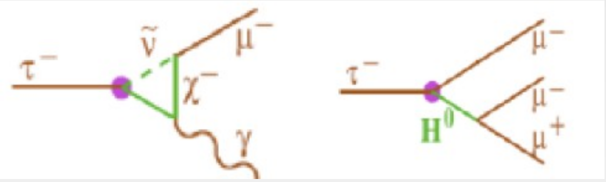
τ Lepton flavour violation

- Lepton flavour violating modes offer experimentally clear and unequivocal signs of NP.
- Standard Model LFV is well below the sensitivity of any experiments for the foreseeable future.
- NP Models can lead to enhancement in LFV τ modes – Belle II will have sensitivity to some of these models.

Standard Model ($\mathcal{B} \sim 10^{-40}$):



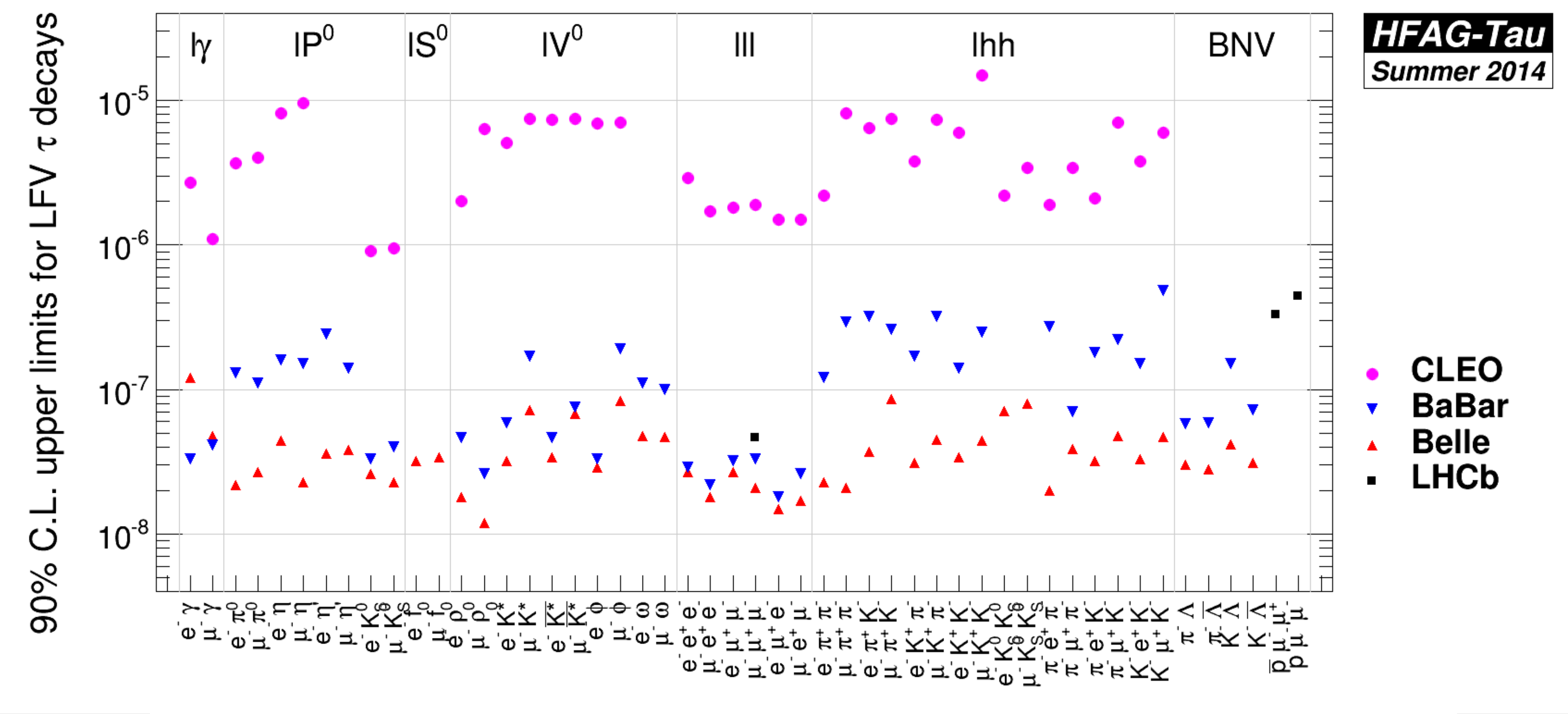
New Physics ($\mathcal{B} \sim 10^{-10} - 10^{-7}$):



	reference	$\tau \to \mu\gamma$	$\tau \to \mu\mu\mu$
SM + heavy Maj ν_R	PRD 66(2002)034008	10^{-9}	10^{-10}
Non-universal Z'	PLB 547(2002)252	10^{-9}	10^{-8}
SUSY SO(10)	PRD 68(2003)033012	10^{-8}	10^{-10}
mSUGRA+seesaw	PRD 66(2002)115013	10^{-7}	10^{-9}
SUSY Higgs	PLB 566(2003)217	10^{-10}	10^{-7}

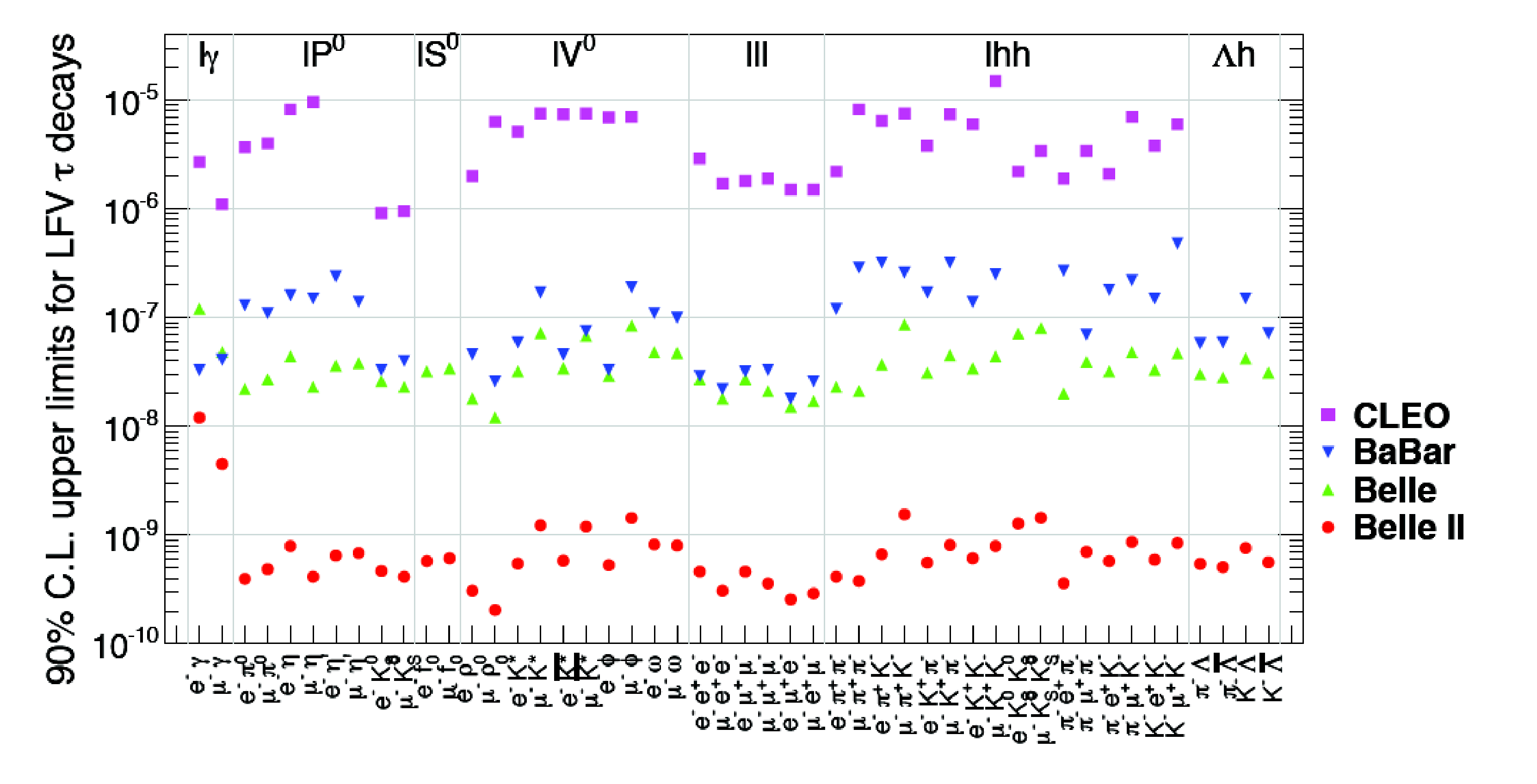
τ Lepton flavour violation

- NP Models can lead to enhancement in LFV τ modes – Belle II will have sensitivity to some of these models.
- Current best limits from experiments:



τ Lepton flavour violation

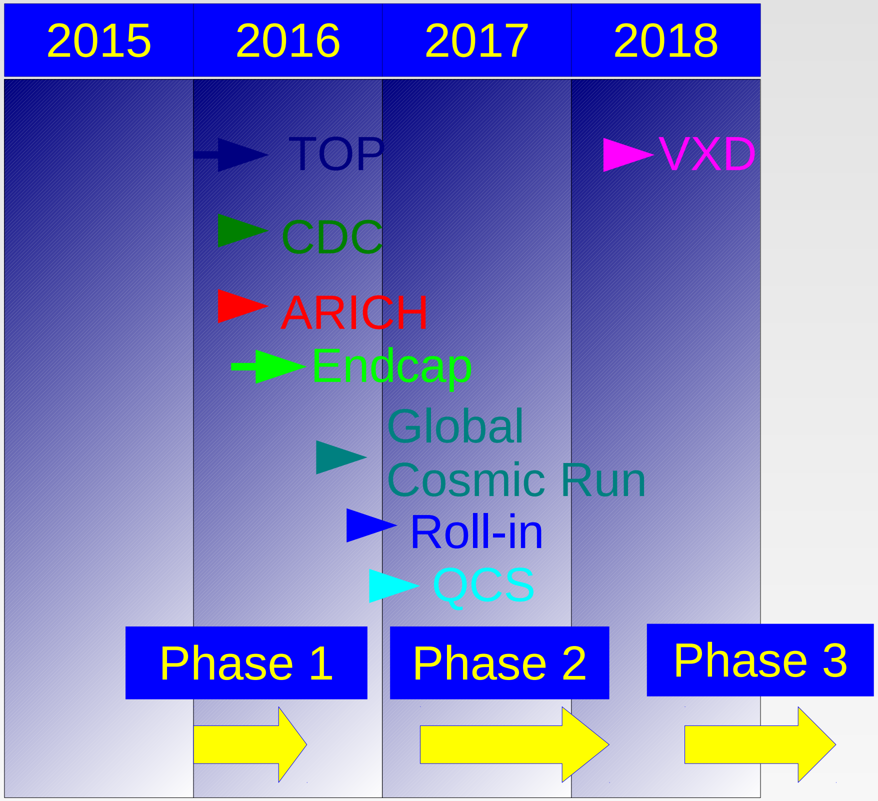
- NP Models can lead to enhancement in LFV τ modes – Belle II will have sensitivity to some of these models.
- Possible Belle II reach (scaled from Belle results (assuming background free)):



Schedule and Commissioning

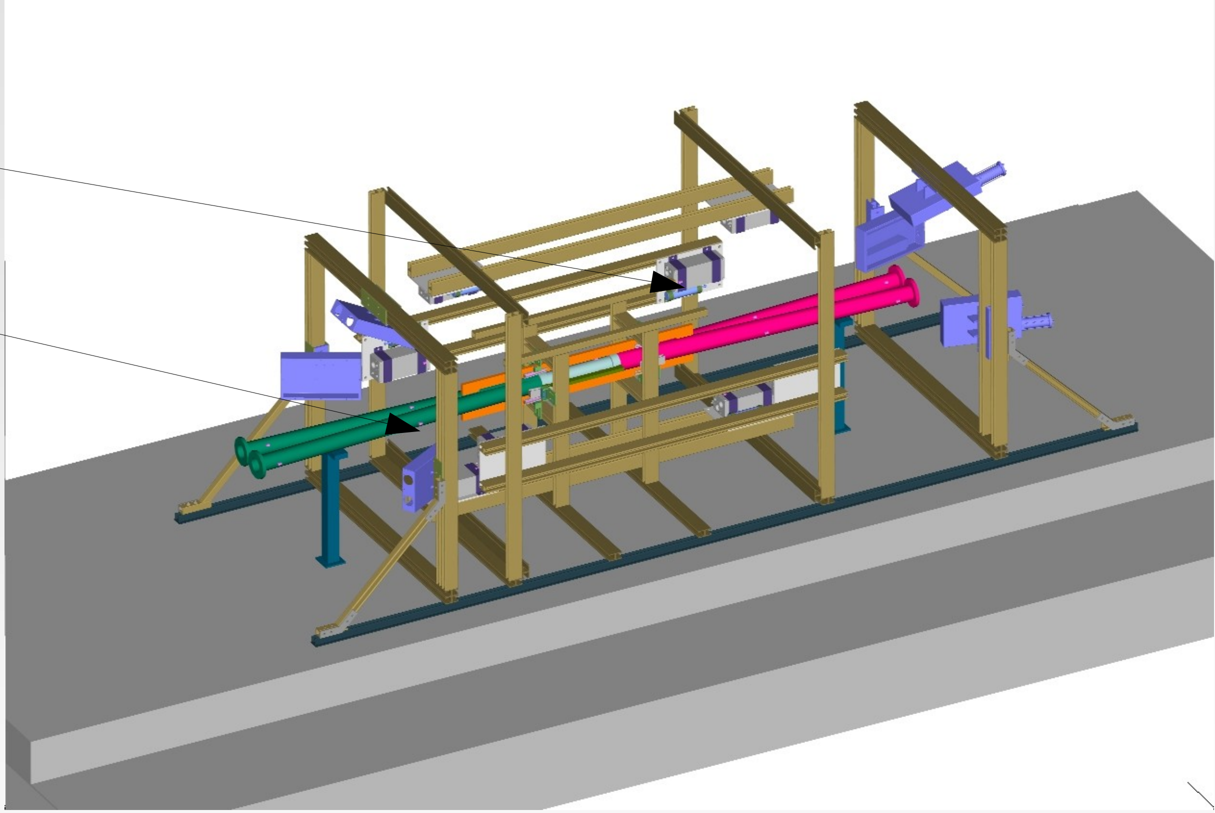
Schedule

- SuperKEKB will start circulating beams in 2016.
- Three Phases in commissioning/operation:
  - Phase 1: Without Belle II. Commissioning detector used.
  - Phase 2: Belle II is rolled in, but without vertex detector.
  - Phase 3: Full Belle II.
- Physics data taking will start in 2018.



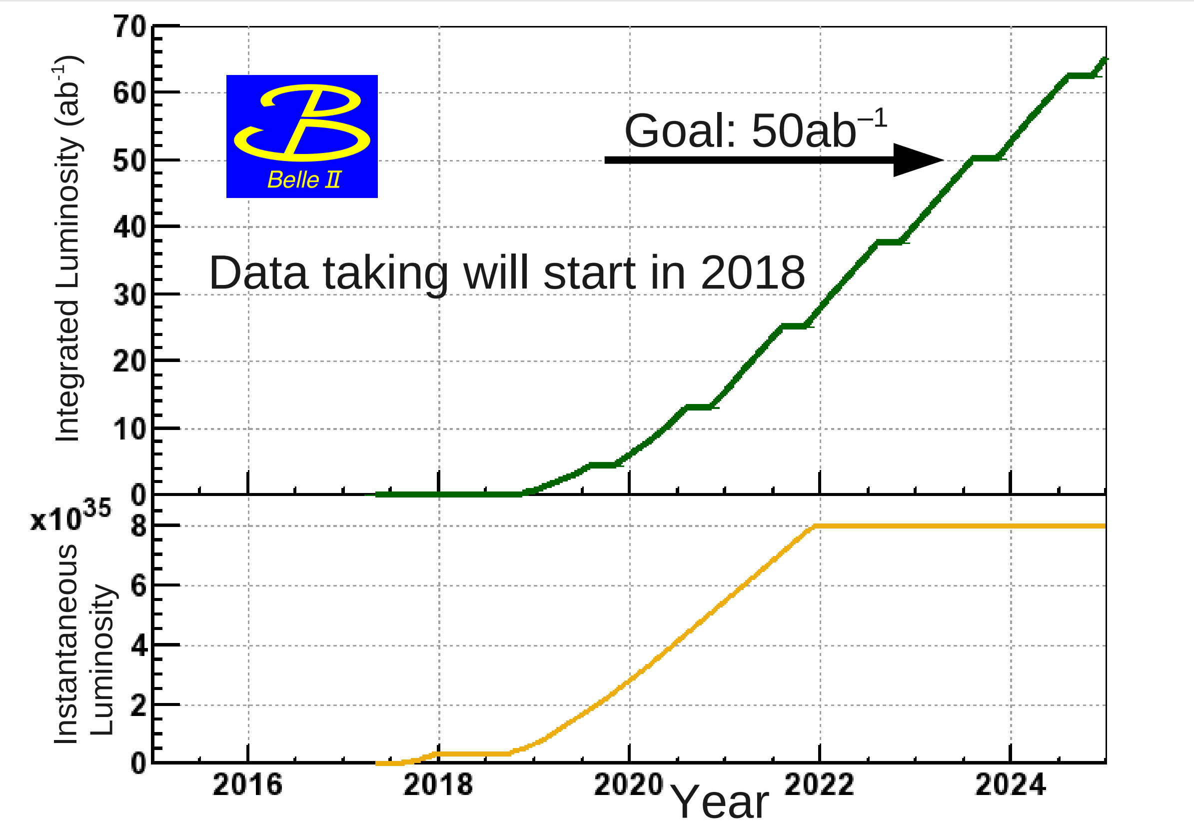
Commissioning Detector

- During phases 1 and 2 a commissioning detector will be used – BEAST II
- Will be used to measure beam backgrounds, before Belle II is rolled in and fully installed.
- Phase 1: 4 MicroTPCs in 8 positions used to measure fast neutron backgrounds, and PIN diodes used to measure ionising particle backgrounds.
- Every other PIN diode coated in gold paint, to allow for separation of charged particle and x-ray contributions.

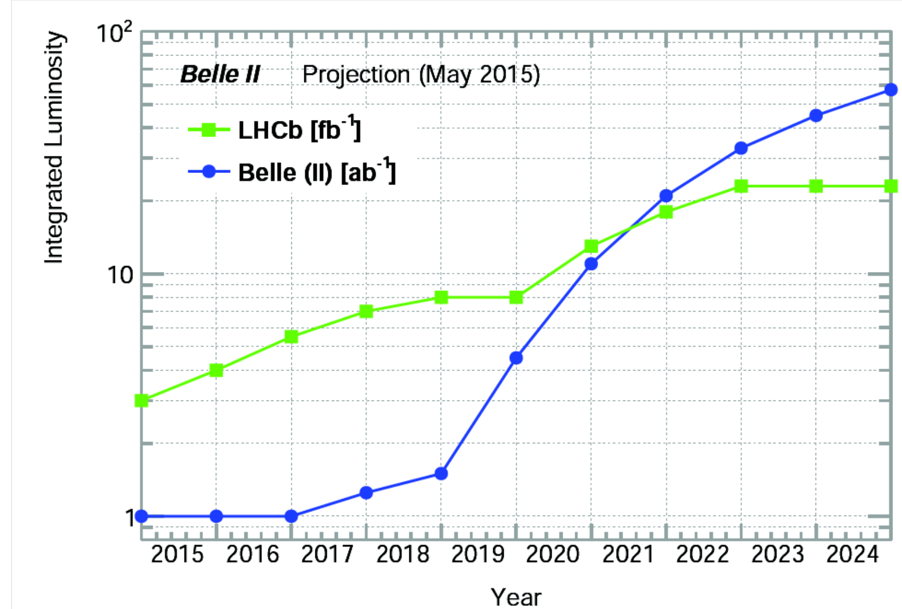


- Crystals and slow neutron counters will also be used.

Luminosity Projections



Comparison of Belle (II) and LHCb luminosities (note different units).



BELLE2-NOTE-PH-2015-04

Belle II Theory Interface Platform

Belle II Theory Interface Platform

https://belle2.cc.kek.jp/~twiki/bin/view/Public/B2TIP

Joint theory-experiment effort to study the potential impacts of the Belle II program, and complementarity with LHCb.

2 workshops a year, starting in June 2014. **Received very well by theory and Belle II.**

What's new in Belle II compared to Babar/Belle?
- ➡ Efficiencies and precision of the new hardware
- ➡ New analysis softwares and methods

What's new in theory after Babar/Belle & LHCb result?
- ➡ Progresses in QCD
- ➡ New physics models and their constraints
- ➡ New observables

→ **NEW IDEAS** ←

Deliverable: "KEK yellow report" by the end of 2016

P. Urquijo

Next meeting: October 2015 at KEK.

Summary

- Rich and successful physics programme at the B-factories.
    - Many hints of new physics.
- To unlock these will require Belle II and the LHC.
- Belle II will start taking physics data in 2018.
- Belle II goal of 50ab-1 will provide:
    - a much larger data set than the B factories;
    - greater sensitivity in many areas of flavour, CP, and related physics areas;
    - New Physics?

ありがとうございました

Backup

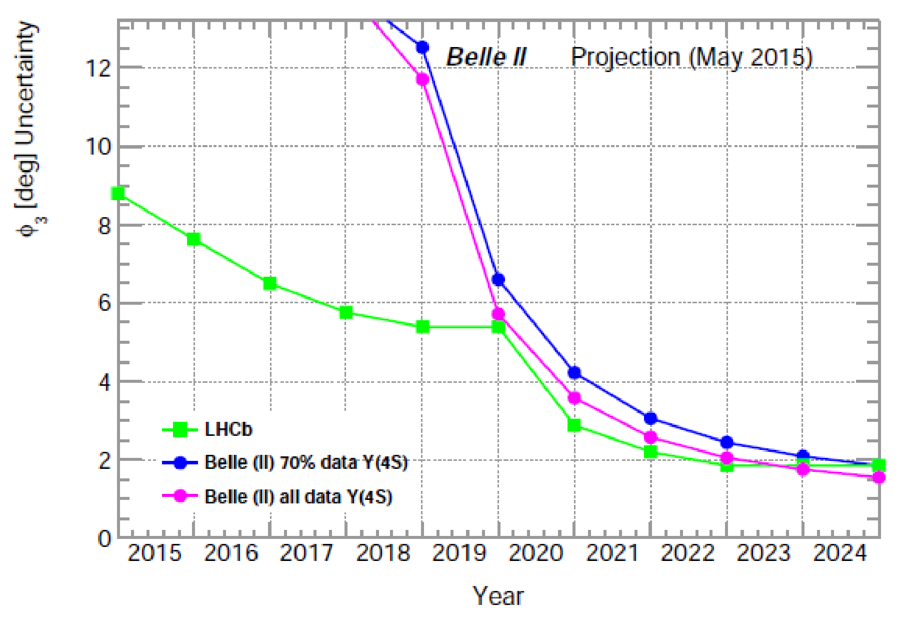
SuperKEKB

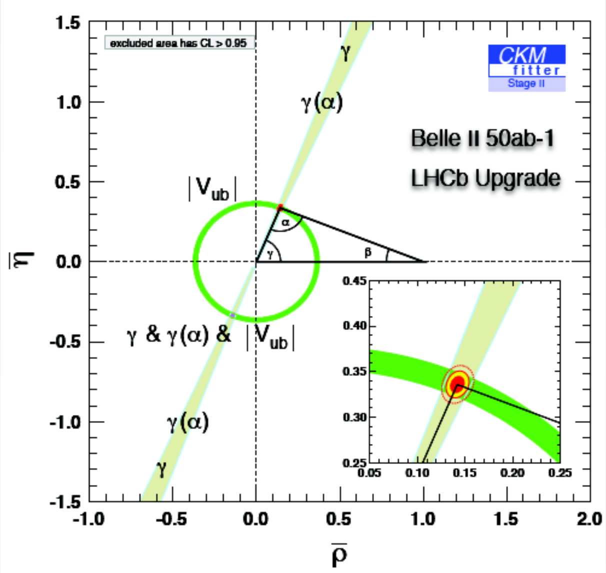
Machine design parameters

parameters		KEKB LER	KEKB HER	SuperKEKB LER	SuperKEKB HER	units
Beam energy	E_b	3.5	8	4	7	GeV
Half crossing angle	φ	11		41.5		mrad
Horizontal emittance	ε_x	18	24	3.2	4.6	nm
Emittance ratio	κ	0.88	0.66	0.37	0.40	%
Beta functions at IP	β_x^*/β_y^*	1200/5.9		32/0.27	25/0.30	mm
Beam currents	I_b	1.64	1.19	3.60	2.60	A
beam-beam parameter	ξ_y	0.129	0.090	0.0881	0.0807	
Luminosity	**L**	**2.1×10^{34}**		**8×10^{35}**		**$cm^{-2}s^{-1}$**

The angle ϕ_3 ($\equiv\gamma$)

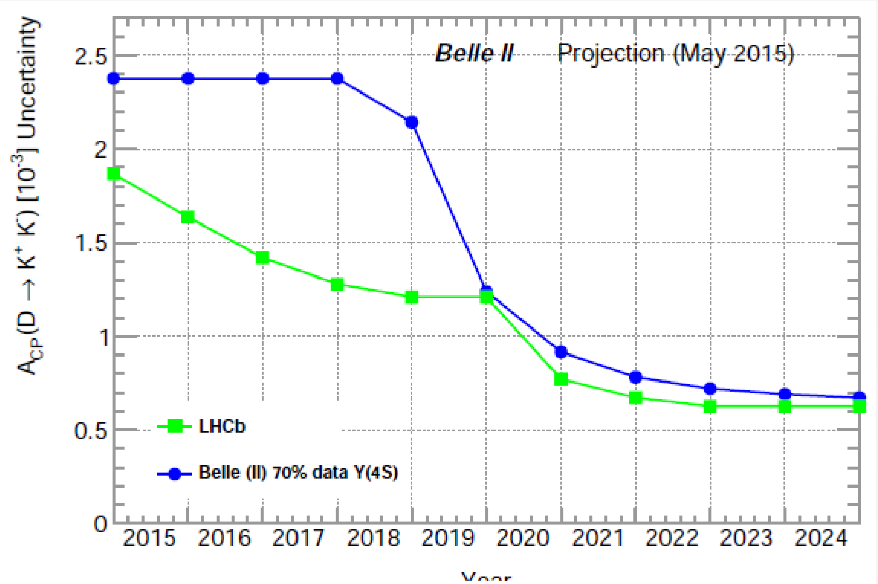
- Project measurement of ϕ_3 from $B\to D^{(*)}K^{(*)}$ decays.

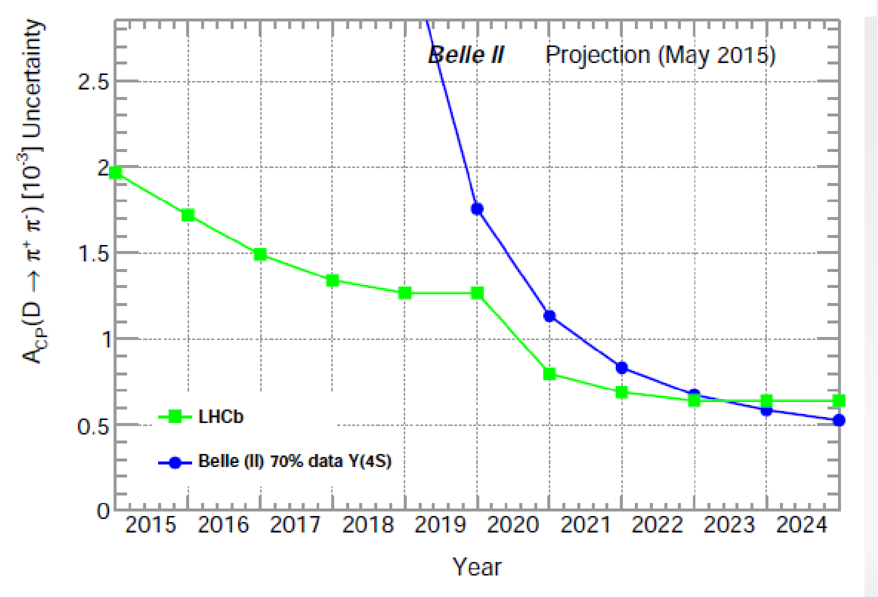




Charm physics CPV

- Both Belle II and LHCb will be able to measure $D \to KK$ and $D \to \pi\pi$ well.
- As with the earlier B physics example, a full isospin analysis will require neutral modes with K^0 and π^0 where Belle II will have greater potential.





Observables	Belle (2015) $(\sigma_{stat}, \sigma_{sys})$	Belle II 50 ab^{-1} $(\sigma_{stat}, \sigma_{sys})$	LHCb Run-1 $(\sigma_{stat}, \sigma_{sys})$	23 fb^{-1} $(\sigma_{stat}, \sigma_{sys})$
$A_{CP}(D \to K^+K^-)$ $[10^{-3}]$	(2.1, 0.8)	(0.3, 0.6)	(1.5, 1.0)	(0.4, 0.5†)
$A_{CP}(D \to \pi^+\pi^-)$ $[10^{-3}]$	(3.8, 1.0)	(0.5, 0.2)	(1.9, 1.0)	(0.4, 0.5†)
ΔA_{CP} $[10^{-3}]$	(4.1, 0.6)	(0.6, 0.3†)	(1.6, 0.8)	(0.4, 0.4†) $(B \to D^0 \mu X)$
A_Γ $[10^{-4}]$	(20, 8)	(3, 2)	(6.2, 1.2)	(1.3, 0.6‡) $(D \to KK)$

B2TIP

Belle II Theory Interface Platform (B2TIP)

Overview

The "Belle II-Theory Interface Platform" is a joint theory-experiment effort to study the potential impacts of the Belle II program.

We plan to organise meetings twice a year gathering theory experts and Belle II members, starting from June 2014 until the end of 2016.

One of the expected outcomes of the project is a "KEK Green Report", summarising all the important observables which will be measured at Belle II, their experimentally achievable precision and their impact on our understanding of the theory (Standard Model and New Physics). This report should also include a "milestones table" clarifying the targets for the first 5 to 10 ab-1 of data as well as for the final goal at 50 ab-1.

Table of golden modes (link).

Interim Working Group Reports (link)

This project is an official activity of Belle II, approved by the executive board of the Belle II Collaboration in February 2014.

Workshop Dates

The 2014 meetings will be held at KEK in June and November, as a satellite meeting of the Belle and Belle II General meetings. There is a possibility of holding one workshop in 2015 at an external location. Individual working groups may choose to hold additional meetings. Please register for the meetings on the linked indico pages.

B2TIP Meeting	Meeting Agenda	Belle (II) associated meetings
2014 June 16-17 @ KEK	workshop indico	B2GM June 18-21, BGM June 22-23
2014 October 30-31, merged with KEKFF October 28-29. @ KEK	workshop indico	B2GM November 3-6, BGM November 7-8
2015 February 23-25, New Physics WG @ KIT (Local organiser U. Nierste)	workshop indico	
2015 April 27-29 @ Krakow (Local organiser A. Bozek)	workshop indico	
2015 October (KEK)		BGM October 15-16, B2GM October 19-23
2016 April/May (North America)		